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By Remington Kellogg

With Six Plates

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No. 1 — *Description of the Skull of Pomatodelphis inaequalis Allen*

By Remington Kellogg

Included in the collections of the Museum of Comparative Zoology, Harvard College, is an essentially complete fossilized skull of a porpoise which Dr. Alfred S. Romer, Director, has kindly placed at my disposal for study and description. This specimen was found in sandy clay in the pit of the Homeland Mine, Homeland, Polk County, Fla., during 1957, by the field party of A. Lewis. Before describing the skull, it seems desirable to review briefly the published occurrences of specimens referred to the genus *Pomatodelphis*.

The portion of the right maxillary discovered in the Helvetian "calcaire grossier" of France and subsequently described and figured by Cuvier (Recherches sur les Ossemens Fossiles, 1823, ed. 2, vol. 5, pt. 1, p. 317, pl. 23, fig. 38) did not receive the generic and specific name *Delphinus stenorhynchus* until 1829 (Holl, 1829, p. 70). Although this basal rostral fragment barely exceeded 12 inches in length, it was regarded as belonging to a long-snouted porpoise at least as early as 1834 (Keferstein, 1834, vol. 2, p. 203). In the second edition of his "Recherches," Cuvier (1823, vol. 5, pt. 1, p. 317) states that the type specimen came from the "département de l'Orne," but in the 4th edition (Cuvier, 1836, vol. 8, pt. 2, p. 168) the locality is given as "département de Maine-et-Loire." M. Renou, who presented this specimen to Cuvier, was professor of natural history at Angers, and this fact affords reasonable grounds for the belief that Cuvier was advised subsequent to the 1823 edition that the original locality designation was incorrect. It should be noted also that Cuvier recorded bones of a seal (1836, vol. 8, pt. 1, p. 454) and a sirenian (1836, vol. 8, pt. 2, p. 63) which had been secured by Professor Renou in the department of Maine-et-Loire. Presumably the name *Delphinus renovi* was bestowed on this same specimen by Laurillard (1844, vol. 4, p. 634) in acknowledgment of the collecting activities of Professor Renou. Dr. G. M. Allen (1921, p. 153) referred the Helvetian (Middle Miocene) *stenorhynchus* to the genus *Pomatodelphis* and concluded that the large and somewhat closely crowded proximal alveoli of the French odontocete afforded ample grounds for the specific separation of the newly discovered Florida porpoise.

In 1921, G. M. Allen (1921, p. 148) selected as a type of the new species *Pomatodelphis inaequalis* a fragment of the right maxillary from the mine pit which was being excavated by the Amalgamated Phosphate Co. at Brewster, Polk County, Va. Other cranial fragments from unrecorded localities in Florida, including a portion of the rostrum of one individual as well as the top and the posterior basal region of the cranium of another individual were referred by Allen to this species.

Of less certain generic allocation is the incomplete skull from the lower Miocene "mollasse burdigalienne" quarries of Chamaret, Department of Drôme, France, which Paquier (1894, p. 7) described as *Schizodelphis depereti*. Allen (1921, p. 153) was almost certain that this Burdigalian specimen was referable to *P. stenorhynchus*.

In some of the pits the bedrock (Cooke, 1945) that unconformably underlies the phosphate deposits consists of either yellow sandy limestone (Bartow, Fla.) or light yellow marl and limestone (Mulberry, Fla.). At Pierce, Fla., laminated blue clays underlie the pebble phosphate. These underlying beds have been referred to the middle Miocene Hawthorn formation. The relatively shallow sediments containing phosphates overlying the above strata vary in thickness and in composition. In view of the occurrence in these overlying layers of long-snouted porpoises found elsewhere only in formations of Miocene age, those advocating a Pliocene age for all of these stratified sediments should support such a conclusion by incontestible proof that at least in some localities one or more of these layers are not referable to an older geologic age. It is hardly conceivable that either a complete isolated long-snouted skull or one accompanied by the mandibles could represent specimens derived from a reworking of older Miocene deposits.

Two of the genera of long-snouted porpoises, *Pomatodelphis* and *Schizodelphis*, represented by specimens obtained in the course of commercial mining of the pebble phosphate deposits of Florida, are present in the Helvetian deposits of France, and *Schizodelphis* also occurs in the Helvetian of Switzerland and

Germany. In geological time, *Schizodelphis* makes its first appearance in the Langhian (lower Miocene) deposits of Austria, Switzerland, France, Italy and Egypt. The genus *Schizodelphis* also occurs in the Calvert formation of Maryland, the Kirkwood formation of New Jersey, and the Bolderian of Belgium, all of which are regarded as early upper Miocene. At the present time, *Pomatodelphis* is limited, by known occurrences in Europe, to the Helvetian stage. No skeletal remains attributable to *Schizodelphis* have been recorded from Pliocene deposits in Europe or elsewhere.

From the laminated blue clays underlying the pebble phosphate at Pierce, Polk County, Fla., a larger long-snouted porpoise (*Megalodelphis magnidens* Kellogg, 1944) and a second specimen of a smaller porpoise (*Goniodelphis hudsoni* Kellogg, 1944) have been described. The type specimen of *Goniodelphis hudsoni* (Allen, 1941) was, however, recorded as having been found in the pebble phosphate at Pierce, Polk County, Fla. The stratigraphic position of the occurrence of *Schizodelphis bobengi* (Case, 1934) in the mine at Mulberry, Polk County, Fla., unfortunately was not recorded. The type (No. 828, Florida Geological Survey) of *Schizodelphis depressus* (Allen, 1921) came from the pit of the Dominion Phosphate Company five miles south of Bartow (Sellards, 1915).

Porpoises with skulls characterized by long, narrow rostra are found in most marine Miocene assemblages. The known geological record reveals that the rostra of the porpoises in this line of development became progressively elongated during the Miocene period. To illustrate this observation, reference is made to the lower Miocene Patagonian *Argyrocetus,* whose rostrum was twice as long as the cranium, and to the upper Miocene Calvert *Zarhachis,* whose rostrum was more than five-sixths of the total length of the skull. The rostrum of both *Pomatodelphis* and *Schizodelphis* was equal to or exceeded four-fifths of the total length of the skull. The pronounced elongation of the rostrum and other differential structural details, including the reduplication of the teeth in the upper and lower jaws, may have culminated in an overspecialization which led ultimately to the extinction of this line of odontocete development prior to the Pliocene period.

The precise stratigraphic position of the Tertiary cetaceans recovered during pit-mining operations for phosphates in Florida in a number of instances has not been carefully recorded. Consequently, some difference of opinion has arisen not only regarding the occurrence but also the geologic age of some of the described marine mammals. Our present knowledge of the geologic occurrence of the long-snouted porpoises suggests that a re-evaluation is needed of the criteria on which age determinations of the stratified layers overlying the Hawthorn formation have been based.

The field party recorded the section at the site (Florida Geological Survey Station 57-1-28 B) where the skull (MCZ 4433) was uncovered in the pit of the Homeland Mine as follows:

Top of spoil bank	Top of section
0-17 ft.	Spoil
3½ ft. thick Bed 1	Rubble in yellow-gray, sandy clay. Rubble consists of vesicular, sandy clay and dark brown ironstone.
	Unconformity
3½ to 4½ ft. thick Bed 2	Phosphorite, white pebbles in sandy clay.
	Unconformity
2½ ft. thick Bed 3	Thin layers of sandy clay and phosphate. (MCZ 4433; *Pomatodelphis inaequalis*).
2 to 2½ ft. thick Bed 4	As above but not as stratified and with some H-green clay.
	Unconformity
1 to 1½ ft. thick Bed 5	Stratified rubble, layers and masses of yellow-gray to dark yellow-orange phosphoritic, sandy clay. Upper surface a pavement of dark brown phosphorite.
	Unconformity
3 ft. thick Bed 6	Stratified layers of yellow-gray to dark yellow-orange, phosphoritic (fine to pebble, light to dark-brown colored) sandy clay or clayey sand. Numerous "manatee" bones (MCZ 4431-4432).
Covered to water level.	

Z. S. Altschuler of the U.S. Geological Survey suggests that this field party possibly mistook pronounced lithologic or weathering changes for unconformities.

The rostrum (U.S.N.M. 20738) of the second specimen hereinafter described was found in light tan, medium to coarse, slightly clayey, quartz, phosphate sand approximately 8 feet above the Hawthorn formation in the Noralyn Mine, 3 miles south of Bartow, Polk County, Florida.

The generic diagnosis published by Allen (1921, p. 148) is revised as follows:

Genus POMATODELPHIS G. M. Allen

Pomatodelphis G. M. Allen, Journ. Mammalogy, vol. 2, no. 3, p. 148. August 19, 1921.

Genotype. *Pomatodelphis inaequalis* G. M. Allen.

Diagnosis. Rostrum elongated, attenuated, dorso-ventrally compressed, and equivalent to more than four-fifths (84%) of the length of the entire skull; mesorostral gutter roofed over for most of its length by premaxillaries; width of premaxillary on dorsal surface of rostrum exceeds that of corresponding maxillary; ventral or palatal surface of rostrum formed entirely by maxillaries; premaxillaries seemingly not visible ventrally at or near extremity of rostrum; palate flat, except for longitudinal, median, V-shaped groove formed by bevelled inner edges of opposite maxillaries; alveoli closely approximated, shallow, somewhat slit-like and more or less contracted at one or both ends, except the anteriormost 13 alveoli which progressively increase in size, both transversely and antero-posteriorly as well as in depth toward extremity of rostrum; a row of shallow depressions internal and parallel to alveoli for right tooth row on proximal portion of palate presumably lodged tips of teeth in corresponding mandibular tooth row; vertex of skull not conspicuously elevated; nasal bones sub-rectangular, wider transversely than antero-posteriorly, and smaller than exposed postero-internal portions of frontals on vertex; supraorbital process of frontal noticeably thickened dorso-ventrally, the antero-external portion of each process being conspicuously enlarged and projected upward above level of premaxillaries; supraoccipital wider than high, concave from side to side, and bounded laterally by flaring lambdoid crest; zygomatic process robust, and dorso-ventrally expanded; occipital condyles borne on relatively short necks.

Referred Specimen I

Pomatodelphis inaequalis G. M. Allen

Referred specimen. No. 4433, Museum of Comparative Zoology, Harvard College. Essentially complete skull, but lacking most of right zygomatic process and all the teeth. Collector, A. Lewis, 1957.

Horizon and locality. Bone Valley gravels, Bed 3 (2.5 feet of thin sandy clay and phosphate). Southeast corner of Homeland Mine Pit, Homeland, Polk County, Florida. NE 1/4, NW 1/4 Sec. 4, T 31 S, R 25 E. Middle Miocene.

SKULL

Dorsal view. This skull (Pl. 1) differs in a number of structural details from that of the Miocene *Schizodelphis* although the Polk County form *Schizodelphis depressus* (Allen, 1921) is known solely from fragments of the rostrum. The most obvious peculiarity of the braincase is the protuberant and dorsally elongated antero-external portion of the supraorbital process of the frontal.

Distortion resulting from dorso-ventral crushing of the braincase is shown by lengthwise folding of the parietal in each temporal fossa, by the downwardly pushed posterior end of each supraorbital process of the frontal, and by the outward displacement of the zygomatic process. Except for the portion underlying the premaxillary on the dorsal surface of the cranium and abutting against the crest of the supraoccipital, the remainder of the ascending plate of each maxillary including that which over-rides the supraorbital process of the frontal is destroyed.

The general form of the slender elongated rostrum (Fig. 1 and Pl. 5, fig. 1) is similar to that of *Schizodelphis*, the widest portion being at the level of the antorbital notches. In an interval of 180 mm. the rostrum diminishes in transverse diameter from 106 mm. (at level of antorbital notches) to 55 mm.; the attenuation of the remainder of the anterior portion of the rostrum is more gradual. The rather shallow antorbital notches are bounded by the lachrymal, the maxillary and the supraorbital process of the frontal.

The premaxillaries are somewhat flattened anterior to the antorbital notches for a distance of approximately 60 mm. and then become progressively more convex for an additional 300 mm. On the distal portion of the rostrum (about 400 mm.) the premaxillaries are more noticeably dorso-ventrally flattened and progressively narrowed. The inner borders of the opposite premaxillaries came in contact approximately 170 mm. anterior to the antorbital notches and continued closely approximated to the extremity of the rostrum. Unlike the specimen figured and described by Allen (1921, p. 149, pl. 10, figs. 7-8) this rostrum is more symmetrical and consequently there is a less obvious asymmetrical deformation of the premaxillaries on the proximal portion. The premaxillaries are seemingly fused at the extremity of the rostrum. Posterior to the level of the antorbital notches, the premaxillaries exhibit the maximum transverse expansion behind the nasal passages. Opposite the nasal passage each premaxillary is elevated above the corresponding maxillary and the outer border is rather indistinctly outlined. The posterior end of each premaxillary is somewhat thickened, irregularly truncated and extended backward beyond the nasal bones. On the cranial fragment described and figured by Allen (1921, p. 148, pl. 11, fig. 11) the posterior ends of the premaxillaries are

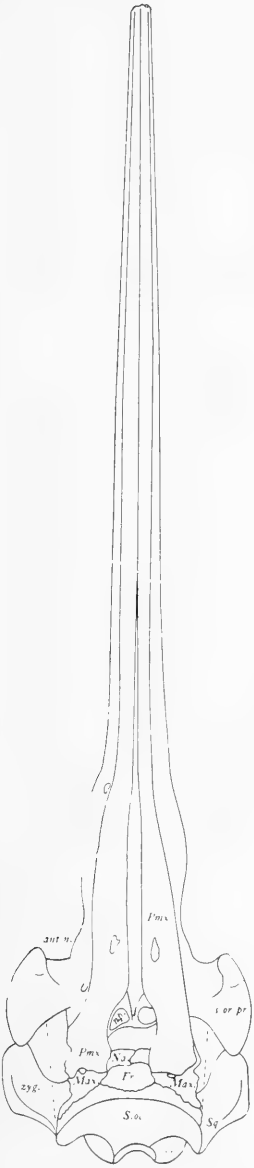

Fig. 1. *Pomatodelphis inaequalis.* Dorsal view of skull, restored. Abbreviations: *ant.n.*, antorbital maxillary notch; *c.*, occipital condyle; *Fr.*, frontal; *Max.*, maxillary; *Na.*, nasal; *n.p.*, nasal passage; *Pmx.*, premaxillary; *Sq.*, squamosal; *S.oc.*, supraoccipital; *s. or. pr.*, supraorbital process of frontal; *zyg.*, zygomatic process.

similarly widened and on both of these specimens a large foramen opens backward under the posterior end of each premaxillary. The premaxillary foramina are large and are located anterior to the level of the antorbital notches. A broad shallow groove extends obliquely backward and inward from each foramen to the internal edge of the premaxillary. With the exception of the proximal 170± mm., the mesorostral gutter was completely roofed over by the close approximation of the opposite inner borders of the premaxillary bones. The floor and sides of the mesorostral gutter on at least the proximal 150 mm. of the rostrum are constituted by the vomer. In front of the nasal passages the vomer is pinched in to conform with the shape of the presphenoid whose lateral surfaces are sheathed at least in part by this bone between these passages. The rather porous presphenoid is largely destroyed but obviously forms a plug at the hinder end of the mesorostral gutter. The preservation of this region does not permit a precise determination of the extent and relations of the mesethmoid. Inasmuch as the anterior wall of the braincase is destroyed in the region where the openings for olfactory nerves persist in some genera, it can not be assumed that the fused ethmoid bones form a continuous sheet of bone overspreading the posterior walls of the nasal passages dorsally.

A V-shaped anterior border of the combined nasal passages is formed by the approximation of the internal edges of the opposite premaxillaries. The lower portion of the posterior wall of each nasal passage is located anterior to the antero-dorsal margin of the nasals, and the dorsal portion of the posterior wall of each passage unfortunately is destroyed.

The maxillaries and premaxillaries constitute the major portion of the dorsal surface of the skull. For a distance of 85± mm. in front of the antorbital notches, the outer border of the maxillary is somewhat compressed dorso-ventrally. In front of this somewhat flattened region, the maxillary from a side view increases in dorso-ventral diameter for a short distance, and then the dorsal surface becomes more convex and the outward slope from the premaxillary-maxillary suture steeper. In conformity with the attenuation of the rostrum, the maxillary decreases in breadth and depth anteriorly. On the major portion of the length of the rostrum the maxillary is rather narrow as compared with the width of the premaxillaries. Posterior to the antorbital notch the maxillary on most porpoise skulls expands horizontally and overspreads the frontal bones. This thin ascending maxillary plate presumably did not completely overspread the supraorbital process of the frontal; the protuberant antero-external angle of the latter certainly projected beyond it. Around the antorbital notch the maxillary overspreads the underlying lachrymal bone. This flattened lachrymal bone was wedged in between the preorbital portion of the supraorbital process and the overlying ascending plate of the maxillary. The maximum width of the maxillary seems to have been attained opposite the vertex, but this can not be ascertained with certainty in view of the damaged condition of both ascending plates of the maxillary above the temporal fossae. Each maxillary is deeply depressed posteriorly, the hinder and inner borders curving upward to the crest of the supraoccipital and to the level of the exposed postero-internal portion of the frontal on the vertex.

The postero-internal portions of the frontals are broadly exposed on the vertex, elevated posteriorly and abut against the transverse crest of the supraoccipital. Allen (1921, p. 148, pl. 11, fig. 11) recognizes an interparietal wedged in transversely between the supraoccipital and the frontals on the cranial fragment referred to this species. The interparietal is not readily recognizable as a distinct bone on this Homeland skull. If present, the boundaries of this bone have been obliterated by ankylosis with the frontals. The thin ascending plates of the maxillaries and the corresponding underlying lateral extensions of the frontals may not have completely roofed over the temporal fossae (Fig. 1). Dorsally, on the braincase, each frontal is largely concealed by the overspreading ascending plate of the maxillary, the premaxillary, and the nasal, and is suturally united posteriorly with the dorsal border of the supraoccipital. The postero-internal portions of the opposite frontals meet edge to edge medially and constitute the vertex which is wider posteriorly than anteriorly and slopes forward from the hinder margin. The thin lateral plate-like extension of each frontal (underlying the corresponding ascending plate of the maxillary) is thickened anteriorly to form the supraorbital process which forms the complete osseous roof of the orbit. The antero-external portion of each supraorbital process is conspicuously enlarged and projects strongly upward above the level of the narial openings.

The nasals are rather small, somewhat rectangular in shape, wider transversely than antero-posteriorly, slightly indented anteriorly, and markedly thickened dorso-ventrally. The dorso-ventral diameter of the left nasal anteriorly is 19mm. The nasals constitute the upper portion of the posterior wall of the nasal passages.

Lateral view. The skull as viewed from the side (Pl. 3) is characterized by a large dorsally prolonged enlargement of the anterior portion of the supraorbital process of the frontal, small orbit, robust dorso-ventrally expanded zygomatic process, flattened vertex, and dorso-ventrally compressed rostrum. At the base of the rostrum the depth (60 mm.) is more than half the corresponding width (106± mm.). For a distance of approximately 120 mm. in front of the antorbital notch the concave external contour of the maxillary is noticeably curved upward. The outward and downward slope of this bone from the premaxillary-maxillary suture becomes steeper toward the level of the hindmost alveolus. Near the extremity of the rostrum the external face of the maxillary is almost vertical. Except for the portion posterior to the level of the hindmost alveolus, the maxillary is relatively thin throughout the length of the rostrum. Although the terminal end of the rostrum is damaged, the portion preserved suggests that the maxillary extended the full length of the rostrum. The alveoli are not visible from a lateral view. The longitudinal groove which follows the line of contact between the maxillary and premaxillary, commencing at the level of the ninth alveolus and extending almost to the anterior end of the rostrum, is deep and well defined.

The dorsal surface of the exposed postero-external portion of the frontal is the highest point on the dorsal profile. The dorsal surface of the vertex slopes forward and downward from the crest of the supraoccipital to the anterior borders of the nasal bones. The premaxillaries slope less strongly downward and the depressed ascending plate of the maxillary slopes more gradually from the supraoccipital toward the antorbital notch.

On its external border, the supraorbital process of the frontal is conspicuously dorso-ventrally thickened. The antero-external angle or preorbital portion of the supraorbital process is markedly enlarged, and projected upward, terminating in a blunt, rounded, crest-like anterior edge. The posterior angle or postorbital portion of the supraorbital process is dorso-ventrally compressed, attenuated, and, prior to crushing, overlapping the anterior extremity of the zygomatic process. The maximum antero-posterior diameter of the left supraorbital process is 85 mm. and the corresponding diameter of the orbit 25 mm. Both lachrymal bones were dislodged and lost; a portion of the depressed area in which the lachrymal was lodged is preserved on the left side of the skull.

The cranium is somewhat dorso-ventrally crushed, resulting in an antero-posterior pressure ridge in the region of the parietal-squamosal sutural contact in the left temporal fossa. On the right side the effect of this crushing is more pronounced. Originally, the temporal fossa may have been almost as long as high. Dorsally the temporal fossa is roofed over at least partially by the thin plate-like lateral extension of the frontal that underlies the ascending plate of the corresponding maxillary, and posteriorly is bounded by the lambdoid crest that follows the lateral margin of the supraoccipital. In the temporal fossa, the parietal is suturally united anteriorly and dorsally with the frontal, posteriorly with the supraoccipital and ventrally with the squamosal. The parietal does not contribute to the formation of the vertex. The laterally flattened zygomatic process is somewhat thicker dorsally than ventrally, obtusely pointed anteriorly, and strongly concave internally; the postglenoid portion is relatively short. The greatest length of the left zygomatic process is 74 mm., and the greatest depth anteriorly 42.5 mm.

As a result of crushing both supraorbital processes have been pushed downward posteriorly from their original alignment and consequently the postorbital portion of each is depressed below the anterior end of the corresponding zygomatic process and the antero-external portion is compensatorily upturned.

Posterior view. The back of the braincase (Pl. 4) displays less evidence of crushing than the lateral walls in the temporal fossae. The supraoccipital is wider than high, concave from side to side, and bounded laterally and dorsally by a flaring lambdoid crest. Externally and ventrally the lambdoid crest follows the contour of the posterior border of the squamosal in the temporal fossa and overhangs the exoccipital on each side. The exoccipitals slope backward and outward, and are prolonged ventrally to form the paroccipital process. Each exoccipital is in contact laterally and anteriorly with the squamosal, coalesced dorsally with the supraoccipital and ankylosed internally with the basioccipital. The deep jugular incisure separates the exoccipital from the falcate process of the basioccipital.

From a posterior view the left zygomatic process is relatively rather broad, projecting laterally noticeably beyond the extremity of the exoccipital.

The foramen magnum was slightly wider than high. The semielliptical occipital condyles are strongly convex dorsoventrally, less convex transversely and are set off laterally from the exoccipital by a short neck. The external and internal borders of each condyle are sharp edged.

Ventral view. The ventral or palatal surface of the attenuated rostrum (Pl. 5, fig. 2) is formed entirely by the maxillaries. No indication of sutures to mark the existence of the premaxillaries on the ventral surface of the rostrum was noted. The palate is quite flat except for the shallow median V-shaped groove, formed by the bevelled inner edges of the opposite maxillaries, which commences at the anterior end of the exposed keel of the vomer (approximately 45 mm. anterior to the level of the hindmost alveolus) and continues forward to within 140 mm. of the anterior extremity.

Commencing at the level of the anterior end of the exposed keel of the vomer the maxillary widens transversely as the antorbital notches are approached. As seen from the ventral aspect of the rostrum (Pl. 2), the external contour of the basal portion of the maxillary is somewhat convex, and agrees in this respect with the type of *Pomatodelphis stenorhynchus.* The tooth row, also, terminates posteriorly at approximately the same relative position as on the type of *stenorhynchus,* although the hindmost alveoli are somewhat smaller. All of the teeth were lodged in the maxillaries. Near the proximal end of the rostrum the maxillaries are separated by the keel of the vomer which is visible on the ventral surface for a distance of 125 mm. Posteriorly, the keel of the vomer seems to have been concealed, at least partially, by the anterior ends of the palatine bones.

Both lachrymal and jugal bones are missing on this skull. The groove or depression in which the lachrymal was lodged is preserved, however, on the left side, and this indicates that this bone was wedged in between the anterior border of the supraorbital process of the frontal and the overlying ascending plate of the maxillary.

On this skull the course of the optic nerve from its point of exit from the cranial cavity to the base of the supraorbital process of the frontal is concealed by the external reduplication of the pterygoid. The groove for this optic nerve on the ventral surface of the supraorbital process becomes indistinct near the middle of its outward course.

Although the palatine bones (Pl. 2) are incomplete in their present state of preservation the dorsal portion of the left palatine is sufficiently well preserved to determine its relations. Each palatine bone is suturally united with the ventral surface of the corresponding maxillary and with the external reduplication of the pterygoid.

On skulls of *Zarhachis* (Kellogg, 1926, pl. 5) and *Eurhinodelphis* (Kellogg, 1925, pl. 1, p. 16), the internal plate of the pterygoid contributes the lower outer wall of the corresponding nasal passage and to a lesser extent the lower anterior wall. Posteriorly the internal plate of the pterygoid overlaps the basisphenoid laterally and is suturally united with the vomer internally. This relationship seems to have been present on this Florida skull although only a remnant of the internal plate of the pterygoid on the outer wall of the right nasal passage is preserved; the portion of the internal plate of each pterygoid which overlaps the basisphenoid is, however, present. These rather fragile pterygoid bones presumably deteriorated during the period when the skull was being buried by sediments. The plate-like internal portion and the external reduplication were obviously separated by a narrow deep sinus apparently not exceeding 5 mm. in width.

Posteriorly, the ventral surface of each maxillary is sheathed by the external reduplication of the pterygoid laterally and by the palatine ventrally. Neither external reduplication of the pterygoid projects forward to the level of the antorbital notches, and each is suturally united with the corresponding palatine anteriorly, the frontal dorsally and the squamosal posteriorly. The anteriorly attenuated deep cavity in front of each nasal passage is bounded medially by the keel of the vomer and laterally by the palatine and the external reduplication of the pterygoid.

The vomer is horizontally widened posteriorly, sheathing the basisphenoid and meeting the vaginal portions of the internal plates of the pterygoids along the vomer's lateral margins. Between the nasal passages the vomer is compressed laterally and forms the trough in which the presphenoid rests. The vomer contributes the lower portion of the posterior and internal walls of each nasal passage and, extending dorsally, presumably meets the descending portions of the ethmoids.

On this skull the line of union between the basisphenoid and basioccipital can not be ascertained with certainty. On each side of the broad median longitudinal elevation the ventral surface of the basioccipital is irregularly depressed internal to its broad convexly curved descending plates or falcate processes. Each of these plates is directed downward and outward, and anteriorly is united with the vaginal portion of the internal plate of the pterygoid which overlaps the basisphenoid. The deep jugular incisure is located between the internal margin of the exoccipital and the posterior margin of the falcate process of the basioccipital.

As pointed out by Allen (1921, p. 150, pl. 11, fig. 12), the occipital condyles of this porpoise are quite large and lack the well developed neck shown on skulls of *Schizodelphis sulcatus* (Abel, 1899, pl. 1, fig. 1; Dal Piaz, 1903, pl. 28).

The squamosal is relatively large and its lateral projection forms the forward projecting zygomatic process. The left zygomatic process is nearly complete; its outer border is curved downward and inward, and the ventral articular surface is strongly concave. It should be noted, however, that the hinder external border of this left process is eroded immediately in front of the rather slender ventral postglenoid projection. A relatively narrow groove for the external auditory meatus, originating at the external margin of the irregular cavity or fossa in which the periotic is lodged, curves outward behind this postglenoid projection. The posterior face of the squamosal abuts against the exoccipital. Behind the above-mentioned groove for the external auditory meatus a short paroccipital process is developed on the ventral border of the exoccipital. The facet on the paroccipital process for articulation with the stylohyal is relatively small and narrow.

No teeth are preserved in the alveoli on either side of the rostrum, (Pl. 5, fig. 2). There are, however, 52 vacant alveoli in the left maxillary. The alveoli of the 13 anteriormost teeth, 40th to 52nd counting forward from the hindmost, progressively increase in size, both transversely and antero-posteriorly toward the extremity of the rostrum. These 13 alveoli occupy an interval of 205± mm. The largest of these anterior alveoli measures 16 mm. antero-posteriorly and 6.5 mm. transversely. Near the middle of the right tooth row, the alveoli vary from 3.5 to 6.5 mm. antero-posteriorly and from 2.5 to 3.5 mm. transversely. The 20 hindmost alveoli in the right maxillary are more closely approximated than in the middle portion of the rostrum. In the right tooth row, counting forward from the hindmost, there are 28 alveoli in 236 mm., and 40 alveoli in 421 mm. Counting forward from the 20th alveolus (143 mm. anterior to hindmost), there are 20 alveoli in 278 mm. These middle alveoli are shallow, somewhat slit-like, and more or less contracted at one or both ends. Most of the teeth in the rostrum were seemingly relatively small, with short, laterally compressed roots held in place by the gums. Allen (1921, p. 150), however, observed that the teeth in the upper jaw must have been very small and non-functional if such existed. Internal to the right tooth row is a parallel row of shallow depressions on the proximal portion of the palate which obviously are attributed to the tips of the mandibular teeth. No similar depressions are present on the left side of the rostrum. Three similarly located depressions are present on the right maxillary of the type of *Delphinus renovi* (= *stenorhynchus;* Van Beneden and Gervais, 1874-80, pl. 57, fig. 9). The rostrum (No. 20738, U.S.N.M.) of a somewhat larger specimen from Polk County, Fla., likewise displays this row of depressions on the right side of the rostrum (Pl. 5, fig. 3). These two Florida specimens, however, do not confirm the observation of Allen (1921, p. 150) that the width across the lower or mandibular tooth rows was less than that across the upper tooth rows.

No satisfactory explanation of the presence of these depressions on only one side of the palate is apparent or can be offered until a mandible of this fossil porpoise is found.

Measurements of the skull (in millimeters)

Greatest length (occipital condyles to extremity of rostrum as preserved)	925
Apex of supraoccipital to extremity of rostrum as preserved	875
Posterior end of ascending plate of right maxillary to extremity of rostrum as preserved	885
Length of rostrum (level of maxillary notches to extremity of rostrum as preserved)	775
Breadth of rostrum at base (between maxillary antorbital notches)	106±
Breadth of rostrum at level of hindmost alveoli	67
Breadth of rostrum at level of alveoli of 20th pair of teeth counting forward from hindmost	43
Breadth of rostrum at level of alveoli of 40th pair of teeth counting forward from hindmost	32.5
Zygomatic width, estimated	210±
Length of left zygomatic process (postglenoid process to extremity)	74
Height of skull, basioccipital to vertex (frontals)	110
Greatest breadth of skull across supraorbital processes, estimated	199±
Dorsal margin of apex of supraoccipital to anterior margin of left nasal	46
Posterior end of ascending plate of left maxillary to level of hinderwall of nasal passages	53
Distance between outside margins of premaxillaries at level of anterior margins of nasal passages	80
Greatest breadth of left premaxillary at level of antorbital notch	33
Maximum distance between inner margins of maxillaries at vertex	36
Greatest antero-posterior diameter of right supraorbital process	87
Greatest length of exposed portion of frontal on vertex	25
Greatest antero-posterior diameter of right nasal	15
Transverse diameter of right nasal	14.5
Greatest transverse diameter of the two nasals	31.5
Distance from dorsal margin of supraoccipital to dorsal margin of foramen magnum	91
Height of foramen magnum	21
Width of foramen magnum	31.5
Greatest distance between outside margins of occipital condyles	88
Greatest height of right occipital condyle	48
Greatest breadth of right occipital condyle	39

Distance between inner margins of alveoli of hindmost teeth in opposite maxillaries		47
Distance between inner margin of 20th alveolus in right maxillary and 20th alveolus in left maxillary (counting forward from hindmost)		24.5
Distance from left antorbital notch to posterior margin of hindmost alveolus in left maxillary		154
Rostrum, left side, distance between margins of alveoli, counting backward from anterior extremity.		
Between 4th and 5th	8 mm.	
Between 5th and 6th	9 mm.	
Between 6th and 7th	9 mm.	
Rostrum, left side, antero-posterior diameter of alveoli, counting backward from anterior extremity.		
5th alveolus	8.5 mm.	
6th alveolus	10.5 mm.	
7th alveolus	8.7 mm.	

POMATODELPHIS STENORHYNCHUS

For reference purposes the following information is here recorded regarding the type specimen of *Pomatodelphis stenorhynchus* (Holl).

Type. No. 2228, Laboratoire de Paléontologie, Museum National d'Histoire Naturelle, Paris. Rostral portion of right maxillary and right premaxillary. Département de l'Orne (=Maine-et-Loire), France. Calcaire grossier.

Measurements of type of *Pomatodelphis stenorhynchus*

(in millimeters).

Maximum total length as preserved (essentially as figured by Cuvier, 1823, pl. 23, fig. 38, at ¼ reduction)	313
Transverse diameter of palatal surface of maxillary at proximal end	66.5
Transverse diameter of palatal surface of maxillary at distal end just posterior to broken end	26.7
Dorso-ventral diameter of maxillary and premaxillary combined at distal end just posterior to broken end	29.8
Dorso-ventral diameter of maxillary and premaxillary combined at proximal end	34.7
Transverse diameter of premaxillary at proximal end	30
Transverse diameter of premaxillary at distal end	13.5

Transverse diameter of maxillary at level of posterior alveolus	40
Hindmost five alveoli occupy an interval of	39
Eight anterior alveoli occupy an interval of	83.5
Antero-posterior diameter of hindmost five alveoli, about	7.2
Transverse diameter of hindmost five alveoli, about	6.5

Originally 20 alveoli were present in this section of the palatal surface of the right maxillary.

Referred Specimen II

Referred specimen. No. 20738, Division of Vertebrate Paleontology, United States National Museum. Incomplete rostrum. Collected by Z. S. Altschuler and E. T. Young, U. S. Geological Survey, Florida Land Pebble Phosphate Area. February 23, 1954.

Horizon and Locality. Three miles south of Bartow, Polk County, Florida. Noralyn Mine, center NE ¼ Sec. 31, T 30 S, R 25 E. In light tan, medium to coarse, slightly clayey, quartz, phosphate sand; in situ in face of active mine pit approximately 8 feet above Hawthorn Ls.

This incomplete rostrum (Pl. 5, fig. 3) lacks the terminal portion and the outer border on both sides between the level of the hindmost alveolus and the antorbital notch. It represents a somewhat larger individual than the skull from the Homeland Mine, the transverse diameter at the level of the hindmost alveoli exceeding the latter by more than 10 per cent. Attenuation of the rostrum may have been rather gradual. The dorso-ventral compression of the rostrum is, however, comparable to that of the specimen from the Homeland Mine. The palatal surface of both maxillaries is flattened except for the narrow longitudinal median groove formed by their bevelled inner borders. In contrast to the Homeland skull, the keel of the vomer is not visible between the maxillaries on the palatal surface of the rostrum.

Thirty-one alveoli are present in the right maxillary, (Pl. 5, fig. 3). For purposes of comparison it should be noted that the 30 posterior alveoli on this rostrum occupy an interval of 422 mm., and on the Homeland Mine specimen these same 30 alveoli are located in an interval of 255 mm. The alveoli for the ten hindmost teeth are placed obliquely to the axis of the major portion of the tooth row and are also more closely spaced than the alveoli anterior to them. Toward the anterior end of this rostral fragment, the alveoli (although more or less slit-like and relatively shallow) progressively increase slightly in antero-posterior diameter. The interval between the alveoli increases irregularly from a minimum of 5 mm. to a maximum of 12 mm. At the posterior end of the palate the opposite tooth rows are separated by an interval of 68 mm. and by 29 mm. at the anterior end of the rostral fragment. Commencing at the level of the 5th alveolus on the right side and terminating at the 17th, there are 19 depressions, variable in depth and more or less parallel to the tooth row, which are presumed to represent pits for the tips of the teeth in the corresponding portion of the mandible.

Both premaxillaries were fractured and detached from the proximal portion of the rostrum when the specimen was uncovered in the mine pit. One section of the right premaxillary measures 420 mm. in length and a shorter more anterior piece 154 mm. A section of the left premaxillary 194 mm. in length was also recovered. These premaxillary bones, although larger, agree in general conformation and attenuation with the corresponding bones of the skull (MCZ 4433) from the Homeland Mine. The internal face of each of these premaxillaries is flattened, the ventral face longitudinally grooved and the dorsal surface convexly curved.

Measurements (in millimeters) of rostrum No. 20738 U.S.N.M.

Total length of rostrum as preserved	579
Breadth of rostrum at level of hindmost alveoli	75
Breadth of rostrum at level of alveoli of 20th pair of teeth counting forward from hindmost	52
Breadth of rostrum at level of alveoli of 30th pair of teeth counting forward from hindmost	45
Anterior end of palatine to level of hindmost alveoli	68
Hindmost 5 alveoli in right maxillary in an interval of	38
Hindmost 10 alveoli in right maxillary in an interval of	88
Hindmost 20 alveoli in right maxillary in an interval of	230
Distance between inner margin of 20th alveolus in right maxillary and 20th alveolus in left maxillary, counting forward from hindmost	35.5
Antero-posterior diameter of 5th alveolus, right maxillary	5.5

Transverse diameter of 5th alveolus, right maxillary	3.5
Antero-posterior diameter of 19th alveolus, right maxillary	6
Transverse diameter of 19th alveolus, right maxillary	2.5

Referred Specimen III

Referred specimen. No. 6683, Division of Vertebrate Paleontology, United States National Museum, anterior extremity of rostrum; and No. 6684, anterior extremity of symphysis of mandibles. Received from H. B. Lunn, August 3, 1910.

Horizon and locality. Christina, about 6½ miles south of Lakeland, Polk County, Florida. Land Pebble Phosphate Area.

The anterior ends of the rostrum (No. 6683, U.S.N.M.) and of the symphyseal portion of the mandibles (No. 6684, U.S.N.M.) of a larger individual show more clearly the details of the large anterior alveoli. Although the right side of the rostrum of the previously described skull (No. 4433, M.C.Z.) is damaged externally, the indentations suggest that originally eight large alveoli were present and that these anterior larger alveoli progressively decrease in size in the antero-posterior direction at least to the 15th and 16th alveoli (counting backward from the anterior extremity).

Six essentially complete large alveoli as well as a portion of the seventh alveolus are present on the left side of this anterior end of the rostrum (Pl. 6, fig. 1). The terminal portions of the roots of the teeth are present in the first and fourth alveoli on the right side (counting backward from the anterior end) and also in the second alveolus on the left side. The ventral surface of the dorso-ventrally compressed rostrum is more or less flattened. No distinct line of separation between the right and left sides of the rostrum is discernible on the ventral surface. The outer face of the rostrum is slightly indented between the alveoli. All of the alveoli are large and are separated by slightly depressed wide intervals. The attenuated root of each tooth extends backward below this interval, and the lateral compression of the basal portion of the alveolus indicates that the root was somewhat flattened transversely. The teeth in the anteriormost pair of alveoli may have projected more forward than downward. The dorsal surface of this anterior portion of the rostrum (Pl. 6, fig. 3) is somewhat convex. The narrow premaxillaries are ankylosed, although a thin longitudinal groove marks the median line of contact. Externally a longitudinal groove which tends to become indistinct some 35 mm. posterior to the anterior extremity delimits each premaxillary. Whether or not the premaxillaries expanded and contributed the anterior end of the rostrum cannot be determined in view of the coalescence of the bones at the extremity. On the dorsal face of the left maxillary four shallow grooves (originating in the above described longitudinal groove), following the lateral border of the corresponding premaxillary, curve downward to the alveolar margin. The dorsal surface of this rostrum is also characterized by the presence of numerous thin curved grooves which suggest that the extremity at least was covered by a tight fitting skin. The maximum length of this rostral fragment is 125 mm.; width anteriorly 28.5 mm.; and width posteriorly, 37 mm.; dorso-ventral diameter anteriorly, 15 mm.; and dorso-ventral diameter posteriorly, 17.5 mm.

The anterior extremity of the symphyseal portion of the mandibles is dorso-ventrally flattened, rounded at the end, and very gradually attenuated. Although the mandibles are firmly ankylosed along the symphysis (Pl. 6, fig. 2), a shallow longitudinal groove marks the contact of the opposite rami dorsally. On the ventral surface the line of contact is less clearly demarcated. Irregular grooves of varying width and depth and directed for the most part anteriorly are present on the ventral surface (Pl. 6, fig. 4). Two nutrient foramina are recognizable on the ventral surface, and some of the numerous narrower grooves apparently anastomose. The dorsal surface of the symphysis is essentially flat transversely. Seven large alveoli are present on the left side of this symphyseal fragment.

All of the teeth with the exception of the 5th and 6th were dislodged from the left ramus and portions of the roots of four teeth are lodged in alveoli in the right ramus. The teeth were implanted opposite one another, and were separated by relatively wide intervals from preceding and succeeding teeth. The root of each tooth extended backward below this interval. The anteriormost alveolus at the extremity of both rami is slightly smaller than the preceding alveolus. These large alveoli slope more backward than inward. The distance between opposite alveoli at the second pair counting backward from the anterior extremity is 10.5 mm. and at the fifth pair 19 mm. In the left ramus five alveoli were located in an interval of 95.5 mm. The roots of the two teeth in situ are conspicuously enlarged below the crown (which apparently was relatively small), transversely compressed, bent backward, and attenuated at the extremity. The outer face of each ramus is indented between the alveoli, suggesting that the opposing teeth on the terminal portion of the rostrum bite between these terminal mandibular teeth. The maximum length of this symphyseal fragment is 133 mm.; width anteriorly, 26 mm.; width posteriorly, 37.5 mm.; dorso-ventral diameter anteriorly, 15 mm.; dorso-ventral diameter posteriorly, 17.5 mm.

Measurements of rostrum, no. 6683, U.S.N.M.

Rostrum, distance between margins of alveoli, counting backward from anterior extremity.

	Right side	Left side
Between 1st and 2nd alveoli	6	6.5 mm.
Between 2nd and 3rd alveoli	9	10 mm.
Between 3rd and 4th alveoli	9.5	8.5 mm.
Between 4th and 5th alveoli	9.5	8.2 mm.
Between 5th and 6th alveoli	9	9.5 mm.
Between 6th and 7th alveoli	x	10 mm.

Rostrum, antero-posterior diameter of alveoli, counting backward from anterior extremity.

	Right side	Left side
1st alveolus	x	x
2nd alveolus	13.5	13.4 mm.
3rd alveolus	11	11 mm.
4th alveolus	10.5	10.3 mm.
5th alveolus	10	10 mm.
6th alveolus	x	9 mm.

Measurements of mandibular symphysis, no 6684, U.S.N.M.

Anterior end of mandibular symphysis, distance between margins of alveoli, counting backward from anterior extremity.

	Right	Left
Between 1st and 2nd alveoli	1.5	2 mm.
Between 2nd and 3rd alveoli	6	6 mm.

	Right Side	Left Side
Between 3rd and 4th alveoli	8.2	8.3 mm.
Between 4th and 5th alveoli	10	7.7 mm.
Between 5th and 6th alveoli	9	6.5 mm.
Between 6th and 7th alveoli	x	8.7 mm.

Anterior end of mandibular symphysis, antero-posterior diameter of alveoli, counting backward from anterior extremity.

	Right	Left
1st alveolus	11	8.8 mm.
2nd alveolus	11.2	11.8 mm.
3rd alveolus	12	12.4 mm.
4th alveolus	11.5	12.5 mm.
5th alveolus	11	11.5 mm.
6th alveolus	x	10.5 mm.

LITERATURE CITED

ABEL, O.

1899. Untersuchungen über fossilen Platanistiden des Wiener Beckens. Denkschr. kais. Akad. Wiss. math. nat. Cl. Wien, vol. 68, pp. 839-874, 4 pls.

ALLEN, G. M.

1921. Fossil cetaceans from the Florida phosphate beds. Journ. Mammalogy, vol. 2, no. 3, pp. 144-159, pls. 9-12.

1941. A fossil river dolphin from Florida. Bull. Mus. Comp. Zool., Harvard College, vol. 89, no. 1, pp. 3-8, 3 pls.

CASE, E. C.

1934. A specimen of a long-nosed dolphin from the Bone Valley gravels of Polk County, Florida. Contrib. Mus. Paleont., Univ. Michigan, vol. 4, no. 6, pp. 105-113, 2 pls.

COOKE, C. WYTHE

1945. Geology of Florida. Florida Geol. Surv., Geol. Bull. no. 29, pp. ix+ 339, 47 figs., 1 map.

CUVIER, G.

1821-1824. Recherches sur les Ossemens Fossiles. Paris, ed. 2, vol. 1, pp. clxiv + 340, 33 pls., 1821; vol. 2, pt. 1, 222 pp., 11 pls., 1822; vol. 2, pt. 2, pp. iv + 229-648, 18 pls., 1822; vol. 3, 412 pp., 80 pls., 1822; vol. 4, 514 pp., 39 pls., 1823; vol. 5, pt. 1, 405 pp., 27 pls., 1823; vol. 5, pt. 2, 547 pp., 33 pls., 1824.

1836. Recherches sur les Ossemens Fossiles. Paris, ed. 4, vol. 1, pp. xxiv + 587; vol. 2, pp. 500; vol. 3, pp. 435; vol. 4, pp. v + 691; vol. 5, pp. 687; vol. 6, pp. 452; vol. 7, pp. 533; vol. 8, pp. 462 + 332; vol. 9, pp. 501; vol. 10, pp. 494. Atlas, vol. 1, pp. 94, pls. 161; vol. 2, pp. 106, pls. 162-260, + A-S.

DAL PIAZ, G.

1903. Sugli avanzi di *Cyrtodelphis sulcatus* dell'arenaria di Belluno. Parte prima. Palaeontographia Italica, Mem. Paleont., Pisa, vol. 9, pp. 187-220, 16 figs., pls. 28-31.

HOLL, F.

1829. Handbuch der Petrefactenkunde. Dresden, 4 vols., pp. viii + 489.

KEFERSTEIN, C.

1834. Die Naturgeschichte des Erdkörpers in ihren ersten Grundzügen. Zweiter Theil, Die Geologie und Paläontologie. Leipzig, pp. iv + 896.

KELLOGG, R.

1925. On the occurrence of remains of fossil porpoises of the genus *Eurhinodelphis* in North America. Proc. U. S. Nat. Mus., vol. 66, art. 25, 40 pp., 17 pls.

1926. Supplementary observations on the skull of the fossil porpoise *Zarhachis flagellator* Cope. Proc. U.S. Nat. Mus., vol. 67, art. 28, 18 pp., 5 pls.

1944. Fossil cetaceans from the Florida Tertiary. Bull. Mus. Comp. Zool., Harvard College, vol. 94, no. 9, pp. 433-471, 10 figs., 6 pls.

LAURILLARD,

1844. Dictionnaire universal d'histoire naturelle (dirige par C. d'Orbigny). Paris, vol. 4, CLA-DIC, p. 634.

PAQUIER, V.

1894. Étude sur quelques Cétacés du Miocène. Mém. Soc. Géol. France, Paléontologie, vol. 4, fasc. 4, mém. 12, pp. 20, pls. 17-18.

SELLARDS, E. H.

1915. The pebble phosphates of Florida. Seventh Ann. Rept. Florida State Geol. Surv., pp. 25-116, 52 figs.

VAN BENEDEN, P. J., AND P. GERVAIS

1874-1880. Ostéographie des Cétacés vivants et fossiles. . . . Paris, viii + 634 pp.; atlas, 64 pls.

PLATES

PLATE 1

Pomatodelphis inaequalis Allen, dorsal view of skull, No. 4433, M. C. Z.

PLATE 1

PLATE 2

Pomatodelphis inaequalis Allen, ventral view of skull, No. 4433, M. C. Z.

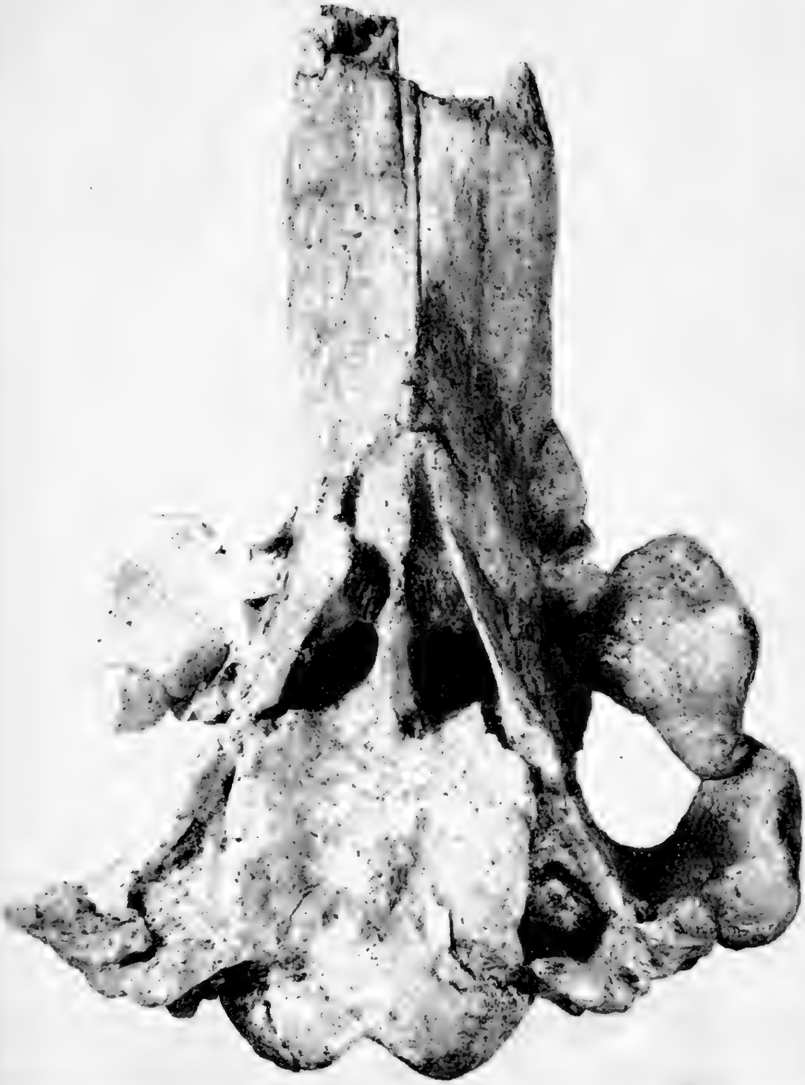

PLATE 2

PLATE 3

Pomatodelphis inaequalis Allen, lateral view of skull, No. 4433, M. C. Z.

PLATE 3

PLATE 4

Pomatodelphis inaequalis Allen, posterior view of skull, No. 4433, M. C. Z.

PLATE 4

PLATE 5

Fig. 1. *Pomatodelphis inaequalis* Allen, dorsal view of rostrum, detached, No. 4433, M. C. Z.

Fig. 2. *Pomatodelphis inaequalis* Allen, ventral view of rostrum, detached, No. 4433, M. C. Z.

Fig. 3. *Pomatodelphis inaequalis* Allen, ventral view of rostrum, No. 20738, U.S.N.M.

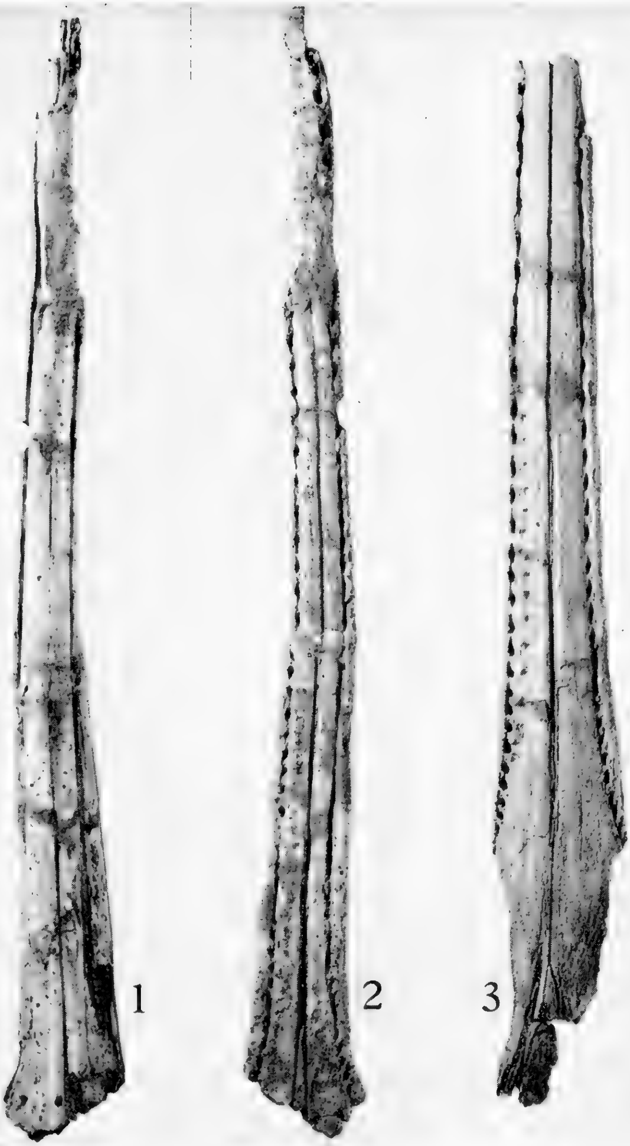

PLATE 5

PLATE 6

Fig. 1. *Pomatodelphis inaequalis* Allen, ventral view of anterior end of rostrum, No. 6683, U.S.N.M.

Fig. 2. *Pomatodelphis inaequalis* Allen, ventral view of anterior end of symphysis of mandibles, No. 6684, U.S.N.M.

Fig. 3. *Pomatodelphis inaequalis* Allen, dorsal view of anterior end of rostrum, No. 6683, U.S.N.M.

Fig. 4. *Pomatodelphis inaequalis* Allen, dorsal view of anterior end of symphysis of mandibles, No. 6683, U.S.N.M.

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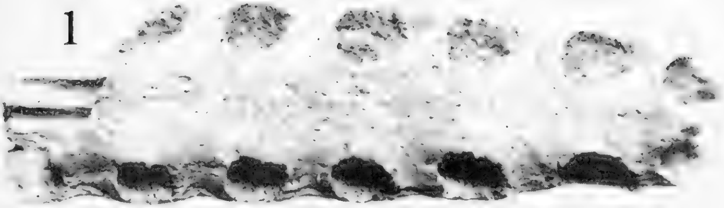

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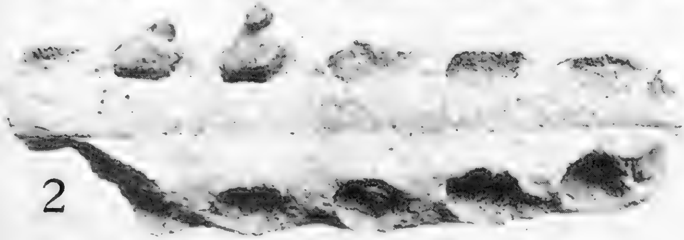

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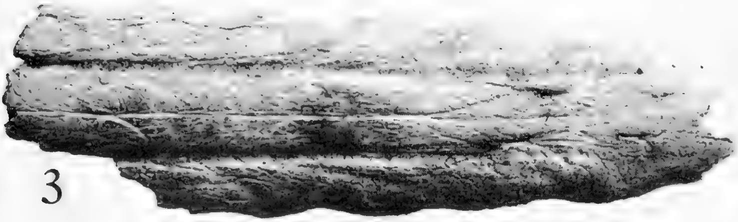

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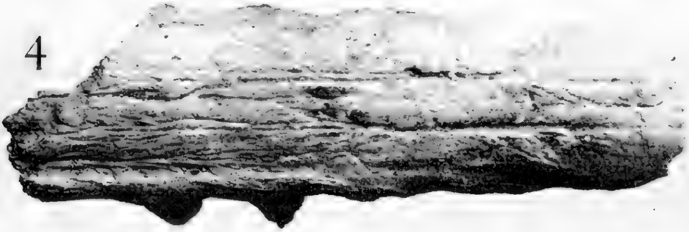

PLATE 6

Bulletin of the Museum of Comparative Zoology
AT HARVARD COLLEGE
VOL. 121, NO. 2

LAND AND FRESHWATER MOLLUSKS OF GREAT AND LITTLE INAGUA, BAHAMA ISLANDS

BY WILLIAM J. CLENCH

WITH ONE PLATE

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
MAY, 1959

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BULLETIN (octavo) 1863 — The current volume is Vol. 121.

BREVIORA (octavo) 1952 — No. 109 is current.

MEMOIRS (quarto) 1864–1938 — Publication was terminated with Vol. 55.

JOHNSONIA (quarto) 1941 — A publication of the Department of Mollusks. **Vol. 3, no. 38** is **current.**

OCCASIONAL PAPERS OF THE DEPARTMENT OF MOLLUSKS (octavo) 1945 — **Vol. 2, no. 22** is **current.**

PROCEEDINGS OF THE NEW ENGLAND ZOOLOGICAL CLUB (octavo) 1899–1948 — Published in connection with the Museum. Publication terminated with Vol. 24.

The continuing publications are issued at irregular intervals in numbers which may be purchased separately. Prices and lists may be obtained on application to the Director of the Museum of Comparative Zoology, Cambridge 38, Massachusetts.

Of the Peters "Check List of Birds of the World," volumes 1-3 are out of print; volumes 4 and 6 may be obtained from the Harvard University Press; volumes 5 and 7 are sold by the Museum, and future volumes will be published under Museum auspices.

Bulletin of the Museum of Comparative Zoology
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With One Plate

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
May, 1959

No. 2 — *Land and Freshwater Mollusks of Great and Little Inagua, Bahama Islands*

By William J. Clench

Great and Little Inagua Islands form the third largest island group in the Bahama Archipelago, exceeded only by Andros (1600 square miles) and the Abaco Islands (776 square miles). The area of the Inaguas is given as 560 square miles, which includes the large inland salt lake on Great Inagua. These islands are situated in the southeastern portion of the Bahama Archipelago, approximately 50 miles from the nearest point in Cuba.

HISTORICAL

Their early malacological history is clouded, as we have but little data on the early collectors. A few species had been collected quite early, mainly before 1850, possibly by some traveler or sailor when his vessel stopped for a cargo of salt, the only commodity supplied by Great Inagua.

Henry Bryant of the Boston Society of Natural History made a short visit to Great Inagua during the winter of 1866. Though interested in bird collecting he devoted considerable time to collecting land mollusks also. His mollusk material was sent to T. Bland of New York City, and Bland in turn sent certain of the questionable species to L. Pfeiffer for additional study and report. This material is now at the MCZ.

Daniel Sargent was American Vice-Consul at Matthew Town during the visit of Henry Bryant. He was influenced by Bryant to collect land mollusks and the material he collected was also sent to T. Bland, at that time the leading authority on West Indian land mollusks. This was about 1866. Sargent collected also on Crooked Island and on Ambergris Cay, Caicos Islands. The shells he collected are in the MCZ and the ANSP.

C. J. Maynard of Newtonville, Mass., spent a short time on Great Inagua in 1888 while on his way to the Cayman Islands. His visit was probably for only a day or so and the material he collected was limited to the genus *Cerion* (Turner 1957). This material is now in the MCZ and the USNM.

Paul Bartsch of the United States National Museum made an extended trip to the southern Bahamas during the summer of

1930, visiting, by chartered schooner, Cay Sal Bank, Ragged Islands, the Crooked Island Group, Mariguana, Great and Little Inagua and the Turks and Caicos groups of islands. This large collection is in the USNM and an exchange series is now deposited in the MCZ.

In 1934 the yacht "Utowana" made a short stay at Great Inagua and several lots of mollusks were collected by Thomas Barbour and J. C. Greenway. This collection is in the MCZ.

In 1936 J. C. Greenway of the Museum of Comparative Zoology and his brother Gilbert visited both Great and Little Inagua by means of a sea plane. Many lots of land mollusks were collected on both islands and the shells given to the MCZ.

R. A. McLean and Benjamin Shreve of the Museum of Comparative Zoology made a trip of several weeks duration to Great and Little Inagua during the summer of 1938. This expedition made the most careful survey of the land and freshwater mollusks so far attempted for these two Islands.

Duplicate material of this expedition as well as that from other sources has been sent on exchange to the ANSP and the USNM.

ACKNOWLEDGMENTS

I am deeply grateful to the many collectors who have made possible this present study. My thanks are due to Dr. Harald Rehder of the United States National Museum who sent on for study the extensive collections made from these islands in 1930 by Paul Bartsch. To the late H. A. Pilsbry I am grateful for an exchange of paratypes of *Cerion* which he had described from Great and Little Inagua. My thanks are also due to Benjamin Shreve for his account of these islands.

I am indebted to my colleagues, Drs. Merrill E. Champion and Ruth D. Turner for reading the manuscript and for aid in many other ways.

ABBREVIATIONS

ANSP. Academy of Natural Sciences, Philadelphia.
MCZ. Museum of Comparative Zoology, Harvard University.
USNM. United States National Museum, Washington, D.C.

A DESCRIPTION OF GREAT AND LITTLE INAGUA[1]

In general, Great Inagua may be described as decidedly flat. The main settlement, Matthew Town, is near the southwest corner of the island. North from Matthew Town, the coastal area is rather densely wooded, the woods seemingly extending for a considerable distance inland. This is particularly marked around the area of Northwest Point where, with somewhat greater rainfall, the trees appear larger than farther south. Also in that area is a salina, roughly about the same size as one just south of Matthew Town. This first-mentioned salina was at one time used for making salt, I was told. Going in an easterly direction behind Alfred Sound (about 1 mile south) are several fresh water ponds, some of which, at least, are joined during periods of high water. My two visits to this area were on July 7 and 22, 1938. The ponds had shrunk considerably between the first and the second visit.

The forested area, as I recall, extends about as far east as Sheep Cay. This small Cay has a considerable number of coconut palms and, in another area, much eroded limestone with holes apparently leading far underground. Going eastward along the north coast the vegetation becomes decidedly scrubby, the whole region having a barren appearance. This was particularly noticeable in the area known as Ocean Bight where enormous rocks were resting just back of the water line. Undoubtedly these had been washed up by a hurricane.

Northeast Point, while not forested, was an area of fairly rich soil. Near Lydia Point there was a colony of negroes engaged in agriculture, sugar cane being one of the crops.

Passing north to Little Inagua, the southwestern part of the island was rather rocky and bare. Centrally there was much eroded limestone, just behind the west coast, with a thick growth of fair sized trees, many sprouting out of holes in the rock. I penetrated a short distance into this but did not see the end of it. The area around North Point was rather open, showing a dried-up salina looking like the Matthew Town salina in miniature.

The east coast of both islands was not seen and so cannot be reported upon.

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[1] By Benjamin Shreve, Research Assistant, Museum of Comparative Zoology.

Returning to Matthew Town and proceeding along the south coast there was found an area of scrubby growth, in some places quite thick. Conch Shell Point on the south side, about 12 miles east of Matthew Town, presented an area of very low scrub about knee high or lower, with cactus frequently seen.

The central part of Great Inagua is occupied by a great salina known as the Lake. It was judged that this was surrounded, except where otherwise noted, by an open desert-like plain with numerous cactus plants of a type which resembled those encountered in far western deserts of the United States. These are apparently well grown examples of ''Turk's Head'' cactus. Groups of palmettos were occasionally encountered, especially near the edge of the west coast forested area. As this central desiccated area was only seen in the environs of its western edge it was assumed to extend only to the Lake. At all events, part of the Lake was forested at its edge, at least in the area of Maroon Hill.

The salina south of Matthew Town has been referred to previously. East of that is Salt Pond Hill, a limestone eminence rising abruptly from the surrounding plain.

The coast line on the west and north is rocky and in some places sandy. The south coast is mainly sandy.

There is a small freshwater pond just outside of Matthew Town similar to those near Northwest Point. This was almost dried up at the time of my departure in August, 1938.

* * * *

NOTES ON THE LAND AND FRESHWATER MOLLUSKS

The 45 species and subspecies of land and freshwater mollusks occurring on Great and Little Inagua can be grouped as follows:

12 occurring in and also beyond the limits of the Bahamas.
3 having a wide distribution in the Bahamas.
6 having a limited distribution in the Bahamas.
23 being peculiar to Great and Little Inagua.
1 introduced species (*Lamellaxis gracilis* Hutton).

This is the same situation which occurs on other island groups so far studied in the Bahamas. Ratios between these numbers differ, of course, but the origin of the molluscan fauna is similar to that of other islands or island groups in that it contains a mixture of elements derived from several sources.

Most of the endemic species and subspecies of the Inaguas are in the families Cerionidae and Pomatiasidae; this is true also of other island groups in the Bahamas. These Inaguan species are generally closely related to species occurring on other islands close to the Inaguas.

The six species of limited distribution in the Bahamas are to be found mainly on the Inaguas and adjacent island groups. The various elements which we consider endemic species have probably occupied these islands for a long period of time and are sufficiently differentiated to be called species. The various species of limited distribution are the same or differ only in a slight degree and therefore can be considered only as isolated populations of a single species.

No species in the pulmonate family Ellobiidae are included in the above tabulation. All species in this family living in the Western Atlantic occur in brackish or salt water and their dispersal is probably by oceanic currents.

LIST OF THE SPECIES KNOWN FROM GREAT AND LITTLE INAGUA, BAHAMAS.

HELICINIDAE

EUTROCHATELLA CALIDA Weinland

Helicina calida Weinland 1862, Malakozoologische Blätter, **9**:91 (Crooked Island, Bahamas).

Remarks. This species has been recorded also from the Caicos Islands, Crooked Island and Acklins Island.

Specimens examined. GREAT INAGUA: 2, 3½ and 4 miles NE of Matthew Town; 9 miles E of Matthew Town; Grey Well; 2 miles SW of Muttonfish Point (all MCZ). LITTLE INAGUA: near Northwest Point (MCZ).

EUTROCHATELLA BRYANTI Pfeiffer

Helicina bryanti Pfeiffer 1858, Malakozoologische Blätter, **14**:165 (Inagua, Bahama Islands).

Remarks. Not quite as abundant as *E. calida* Weinland, though well distributed in the western section of Great Inagua.

Specimens examined. GREAT INAGUA: 1, 6 miles E of Matthew Town; Lydia Point; 2 miles SW of Muttonfish Point; Jackline (all MCZ); Salt Pond Hill; Maroon Hill (both USNM). LITTLE INAGUA: Northwest Point (MCZ); S of Northwest Point (USNM).

EUTROCHATELLA KLINEI, new species
Plate 1, figure 5

Description. Shell small, measuring 3½ mm. in greater diameter, globose-depressed and rather solid in structure. Color a light brownish yellow, somewhat darker on the early whorls. Whorls 4½ and strongly convex. Spire broad, straight-sided and somewhat depressed forming an angle of about 90°. Aperture subcircular. Palatal lip not noticeably thickened, parietal wall thinly glazed. Columella short and arched in front view. There is a very slight umbilical depression. Suture well indented. Sculpture consisting of numerous, well developed, spiral threads which number 26-28 on the body whorl. There is no indication of any axial sculpture. Nuclear whorls about 2 and are extended somewhat above the remaining whorls.

Greater Diameter	*Lesser Diameter*	*Height*	
3.5 mm.	3.1 mm.	2.8 mm.	Holotype
3.	2.9	2.5	Paratype
3.5	3.2	2.7	Paratype

Types. Holotype, Museum of Comparative Zoology, no. 189603, from northeast of Southwest Point, Little Inagua, Bahama Islands. R. A. McLean and B. Shreve, collectors, July 19, 1938. Paratypes from the same locality in the Museum of Comparative Zoology, the United States National Museum, Museo Poey, University of Habana, and the collection of E. C. Doremus.

Remarks. This species appears to be nearest in relationship to *Eutrochatella bryanti* Pfeiffer from Great Inagua. It differs, however, in being much smaller, usually no more than half the size of *bryanti*, having a nearly straight-sided spire and in having much stronger spiral threads. *E. bryanti* has a very definite convex shape to the spire.

This species is named for Mr. George F. Kline of Madison, New Jersey, to whom we are indebted for much Bahama material.

ALCADIA (ANALCADIA) MOUSSONIANA Pfeiffer

Helicina moussoniana Pfeiffer 1866, Malakozoologische Blätter, **13**:89 (Turks Island, Bahamas).

Remarks. This is the most abundant species among the Helicinidae occurring in the Inaguas. It is found also on Turks and Caicos Islands and on Mariguana Island.

Specimens examined. GREAT INAGUA: 2, 3½, 4, 7 and 9 miles NE of Matthew Town; 1½ miles SE of Matthew Town; 1, 2 miles E of Matthew Town; 1½ miles SE of Grey Well; Calm Cove, near Northwest Point; 1 mile W of Conch Shell Point; Jackline; 2 miles SW of Muttonfish Point; Canfield Bay; Lantern Head (all MCZ); E end of Salt Pond; Maroon Hill (USNM). LITTLE INAGUA: Northwest Point (MCZ); bay S of Northwest Point (USNM).

HELICINA RAWSONI Pfeiffer

Helicina rawsoni Pfeiffer 1867, Malakozoologische Blätter, **14**:165 (Inagua Island, Bahamas).

Remarks. Lectotype, here selected, Museum of Comparative Zoology no. 90179, from the Thomas Bland Collection, collected originally by Henry Bryant.

This species appears to be quite rare. McLean and Shreve found only a single specimen. It is, however, widely distributed in Bahama Archipelago.

Specimens examined. GREAT INAGUA: Matthew Town; 1½ miles SE of Grey Well (both MCZ).

LUCIDELLA (POENIELLA) TANTILLA Pilsbry

Helicina tantilla Pilsbry 1902, Nautilus, **16**:53 (Palm Beach, Florida).

Lucidella tantilla Pilsbry 1948, Monographs, Acad. Nat. Sci. Philadelphia, no. 3, **2**, pt. 2, p. 1085, text fig. 580.

Remarks. Bahama records for this species have been heretofore confined to the northern islands such as Mores Island, Great Abaco Island and the Bimini Islands. It is an exceedingly small species, scarcely more than 2 mm. in greater diameter. Our single new record is from Northwest Point, Little Inagua. It did not appear at any of the many stations made by McLean and Shreve on Great Inagua. The present series from Little Inagua agree in all details with specimens from the Bimini Islands except in having somewhat finer axial sculpture.

An additional Cuban locality for this species is Cayo las Brujas, Caibarién. These specimens are an exact counterpart of the Bimini Island series. This extends the Cuban distribution considerably west of its only known occurrence, until now, on Monte Toro in eastern Cuba. It is probably far more abundant in eastern and central Cuba than these two localities would indicate, as its small size and habitat among leaves and humus, make it relatively difficult to find. In addition to Cuba and the Bahamas, it is known from several localities in southern Florida.

Specimens examined. LITTLE INAGUA: Northwest Point (MCZ; USNM).

POMATIASIDAE

The monograph of this family by Bartsch[2] covering the Bahama Islands and Hispaniola leaves much to be desired. So far as the species from the islands of Great and Little Inagua are concerned, references had to be made to the original descriptions of every species to be at all certain of the correct names. Most of the new species and subspecies described by Bartsch are but slight variations of well known forms and at best are but localized populations.

CHONDROPOMA RAWSONI Pfeiffer

Plate 1, figure 7

Chondropoma rawsoni Pfeiffer 1867, Malakozoologische Blätter, **14:166** (Inagua, Bahamas).

Chondropoma (*Levipoma*) *inaguativum* Bartsch 1946, Bull. United States National Mus. no. 192, p. 187, pl. 32, fig. 6 (west of Salt Pond Hill, Great Inagua).

Chondropoma (*Levipoma*) *inaguativum petersi* Bartsch 1946, Bull. United States National Mus. no. 192, p. 188, pl. 32, fig. 4 (North Point, Ocean Bight, Great Inagua).

Chondropoma (*Levipoma*) *inaguellum* Bartsch 1946, Bull. United States National Mus. no. 192, p. 188, pl. 32, fig. 1 (Northwest Point, Little Inagua).

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[2] 1946, United States National Museum, Bull. no. 192, pp. 1-264, 38 plates.

Remarks. This is a species of wide distribution on Great Inagua, occurring wherever there is a little ground cover and dead leaves.

A lectotype, here selected, from Great Inagua is in the Museum of Comparative Zoology, no. 90131.

Bartsch was in complete confusion regarding this species. His "*C. rawsoni* Pfeiffer" is actually *C. biforme* Pfeiffer and the true *rawsoni* of Pfeiffer was described by Bartsch under the names given in the synonymy above.

The series of *C. rawsoni* to which he gave the name *Chondropoma inaguellum* from Little Inagua is open to question. The two expeditions we have had to this island failed to obtain any specimens of *C. rawsoni.* On the other hand, Bartsch failed to find any specimens of *C. inaguense* Weinland which both our parties found at nearly every station. It would appear that there may have been a transposition of labels in the material which Bartsch was studying.

Specimens examined. GREAT INAGUA: 2, 3½ and 4 miles NE of Matthew Town; Sheep Cay; Salt Pond Hill; Lantern Head; Maroon Hill; Kerrline; Conch Shell Point; Calm Cove; Jackline Hill; Canfield Bay; SE of Grey Well (all MCZ).

CHONDROPOMA INAGUENSE Weinland

Cyclostoma (*Chondropoma?*) *inaguense* Weinland 1880, Jahr. Deut. Malak. Gesell., **7**:345, pl. 12, fig. 6 (Little Inagua).

Remarks. This species is generally distributed over Little Inagua. Specimens of this species were collected originally by Sargent and sent to Thomas Bland. Most of Sargent's material was later sent to Pfeiffer and Weinland by Bland.

Specimens examined. LITTLE INAGUA: 1½ and 2 miles S of Northwest Point; Northwest Point; NE of Southwest Point (all MCZ).

CHONDROPOMA BIFORME Pfeiffer

Plate 1, figure 6

Chondropoma biforme Pfeiffer 1858, Malakozoologische Blätter, **5**:143 (Turks Island).

?Chondropoma subauriculatum Pfeiffer 1862, Malakozoologische Blätter, **9**:153 (Cumaná, Venezuela); H. B. Baker 1923, Occ. Papers, no. 137, Univ. of Michigan, Mus. of Zool., p. 26.

Chondropoma biforme neyi Bartsch, 1947, Bull. United States National Mus. no. 192, p. 195, pl. 33, fig. 10 (bay south of North Point [Northwest Point], Little Inagua).

Remarks. Pfeiffer confused two species in his description of *biforme* as his name would indicate. In the material we have at hand for study there do not appear to be any specimens intermediate between the two species. The more abundant species has very fine spiral cords and rather coarse axial threads. This is here selected to be *Chondropoma biforme* Pfeiffer. The second species, which has been named *Chondropoma inaguicolum* Bartsch, has fewer but much coarser spiral cords and very fine axial threads.

A lectotype, here selected, of *C. biforme* is in the Museum of Comparative Zoology, no. 78149, from Turks Islands.

There appears to be little question that *Chondropoma subauriculatum* Pfeiffer, described as from Cumaná, Venezuela, is *C. biforme.* Syntypes in our collection from Bland are identical with specimens of this species from Turks Island in the Bahamas. A mixture of labels was possibly responsible for this error.

Specimens examined. Great Inagua: 1 and 1½ miles E of Matthew Town; 1½ miles SE of Matthew Town; 7 miles NE of Matthew Town; near Grey Well; Maroon Hill; salina near Northwest Point (all MCZ). Little Inagua: Northwest Point; 2 miles S of Northwest Point; NE of Southwest Point (all MCZ).

This species occurs also in the Turks Islands.

CHONDROPOMA BIFORME EUPLOCA Dall

Rhytidopoma euploca Dall 1905, Smithsonian Misc. Collections, **47**:499, pl. 59, fig. 6 (Great Inagua, Bahamas).

Chondropoma russelli Clench 1937, Proc. New England Zool. Club, **16**:67, pl. 3, fig. 3 (Great Inagua Island, Bahamas).

Remarks. All of the specimens of this subspecies were collected originally by Henry Bryant from an unlocalized area on Great Inagua. The expedition conducted by McLean and Shreve failed to find it. Dall's type series of three specimens originally came from Thomas Bland to whom Bryant had sent his material for determination and study. I had unfortunately overlooked Dall's name and renamed it *russelli*.

Specimens examined. Great Inagua: (MCZ; USNM).

CHONDROPOMA INAGUICOLUM Bartsch

Chondropoma (Chondrops) inaguicolum Bartsch 1946, Bull. United States National Mus., no. 192, p. 190, pl. 33, fig. 2 (south of Northeast Point, Great Inagua, Bahamas).

Remarks. This species appears to be limited to the northern coast of Great Inagua. Bartsch reports this species from Little Inagua but McLean and Shreve failed to find any specimens at the several places they investigated on this smaller island.

Specimens examined. GREAT INAGUA: Canfield Bay; 1 mile SW of Clarkeville (both MCZ). LITTLE INAGUA: (USNM).

COLONIA BRYANTI Pfeiffer

Ctenopoma bryanti Pfeiffer 1867, Malakozoologische Blätter, **14**:130 (Great Inagua, Bahamas).

Colonia bryanti minor Bartsch 1946, Bull. United States National Mus., no. 192, p. 244, pl. 38, fig. 6 (Conch Shell Point, Great Inagua, Bahamas).

Colonia inaguella Bartsch 1946, Bull. United States National Mus., no. 192, p. 245, pl. 38, fig. 13 (south end of Little Inagua, Bahamas).

Remarks. This species occurs rather generally over most of Great and Little Inagua Islands. In our opinion neither *minor* nor *inaguella* can be separated from *bryanti.* The differences given by Bartsch do not exist in the material we have studied from the same localities.

Specimens examined. GREAT INAGUA: Matthew Town; 1½ miles SE of Matthew Town; 1 mile E of Matthew Town; 2 and 3½ miles NE of Matthew Town; 6 miles ENE of Matthew Town; Mangle Bush; Calm Cove; Salt Pond Hill; 1½ miles SE of Grey Well; 1 mile W of Conch Shell Point (all MCZ). LITTLE INAGUA: Southwest Point; NE of Southwest Point; 2 miles S of Northwest Point (all MCZ).

AMNICOLIDAE

LITTORIDINA TENUIPES Couper

Amnicola tenuipes Couper 1844, [in] S. S. Haldeman, Monograph Limniadae of North America, Philadelphia, pt. 7, p. 23, pl. 1, figs. 14-15 and p. 4 of cover (Hopeton, Georgia).

Remarks. A few dead specimens were obtained at a single locality. These agree in all details with specimens that we have from both Grand Bahama and Eleuthera Islands. This species also occurs in Georgia and Florida.

Specimens examined. Great Inagua: Shore of Lake, 7 miles NE of Matthew Town (MCZ).

ELLOBIIDAE

Detracia bullaoides Montagu

Voluta bullaoides Montagu 1808, Testacea Britannica, Supplement, p. 102, pl. 30, fig. 6 (locality unknown).

Specimens examined. Great Inagua: 3 miles SE of Matthew Town (MCZ).

Little or no attempt was made by McLean and Shreve to collect mollusks in marine or brackish water. Time was limited and it was all important to cover these islands for their land and freshwater species. There is no question but that all of the known ellobiids from other Bahama Islands also occur on the Inaguas.

LYMNAEIDAE

Lymnaea (Galba) cubensis Pfeiffer

Lymnaeus cubensis Pfeiffer 1839, Archiv für Naturgeschichte, Wiegmann, **5**:354 (Cuba).

Specimens examined. Great Inagua: Horse Pond, 1 mile NE of Matthew Town; 1½ miles SE of Grey Well (both MCZ).

PLANORBIDAE

Tropicorbis albicans Pfeiffer

Planorbis albicans Pfeiffer 1839, Archiv für Naturgeschichte, Wiegmann, **5**:354 (Cuba).

Specimens examined. Great Inagua: Horse Pond, 1 mile NE of Matthew Town; 1½ miles SE of Grey Well (both MCZ); 2 miles N of Matthew Town (USNM).

Drepanotrema cimex Moricand

Planorbis cimex Moricand 1839, Mem. Soc. Phys. Genève, **8**:143, pl. 3, figs. 8-9 (Bahia, Brasil).

Specimens examined. Great Inagua: 1½ miles SE of Grey Well; shore of Lake, 7 miles NE of Matthew Town (both MCZ); Lake margin, 2 miles N of Matthew Town (USNM).

ANCYLIDAE

GUNDLACHIA ANCYLIFORMIS Pfeiffer

Gundlachia ancyliformis Pfeiffer 1849, Zeitschrift für Malakozoologie, **6**:98 (Cuba).

Specimens examined. GREAT INAGUA: Horse Pond, 1 mile NE of Matthew Town (MCZ).

SUCCINEIDAE

SUCCINEA BARBADENSIS Guilding

Succinea barbadensis Guilding 1828, Zoological Jour., **3**:532 (Barbados).

Specimens examined. GREAT INAGUA: 3½, 6, and 7 miles NE of Matthew Town; Horse Pond, 1 mile NE of Matthew Town; 2 miles SW of Muttonfish Point; 1½ miles SE of Grey Well (all MCZ); Conch Shell Point; Salt Pond Hill; Maroon Hill (all USNM).

PUPILLIDAE

PUPOIDES MARGINATUS NITIDULUS Pfeiffer

Bulimus nitidulus Pfeiffer 1839, Archiv für Naturgeschichte, Wiegmann, **5**:352 (Cuba).

Pupoides marginatus nitidulus Pfeiffer. Pilsbry 1921, Man. of Conch., (2)**26**:113, pl. 12, figs. 9, 16.

Specimens examined. GREAT INAGUA: 1, 1½, and 2 miles E of Matthew Town; 3½ miles NE of Matthew Town; 6 miles ENE of Matthew Town; Maroon Hill; Salt Pond Hill; 2 miles SW of Muttonfish Point (all MCZ); Ocean Bight (USNM).

GASTROCOPTA PELLUCIDA Pfeiffer

Pupa pellucida Pfeiffer 1841, Symbolae ad Historiam Heliceorum, **1**:46 (Cuba).

Specimens examined. GREAT INAGUA: 1, 1½, 2, and 6 miles E of Matthew Town; 2, 3½, 4, 7, and 9 miles NE of Matthew Town; Calm Cove; Kerrline; 2 miles SW of Muttonfish Point; Canfield Bay; Northwest Point (all MCZ); Conch Shell Point; Carmichael Point (both USNM). LITTLE INAGUA: Northwest Point (MCZ; USNM).

STROBILOPSIDAE

STROBILOPS HUBBARDI VENDRYESIANA Gloyne

Helix vendryesiana Gloyne 1871, Jour. de Conchyliologie, **19**:333 (Bellevue, St. Andrew, Jamaica).

Strobilops hubbardi vendryesiana Gloyne. Pilsbry 1927, Man. of Conch., (2)**28**:48, pl. 7, figs. 4-12; pl. 8, figs. 1-9.

Remarks. Only two specimens of this species have been obtained. Typical *S. hubbardi* Brown has been found in the Bimini Islands. Probably both forms occur on other islands in the Bahamas but because of their small size these mollusks are easily overlooked. This subspecies has been recorded as well from Cuba, Bermuda, Florida and Mexico.

Specimens examined. GREAT INAGUA: Kerrline; Jackline Hill (both MCZ).

SUBULINIDAE

LAMELLAXIS (ALLOPEAS) GRACILIS Hutton

Bulimus gracilis Hutton 1834, Jour. Asiatic Soc. Bengal, **3**:93 (Mirzapur, Ceylon).

Remarks. Only a single specimen of this species was collected. It is widely distributed throughout most of the West Indies.

Specimens examined. GREAT INAGUA: 2 miles E of Matthew Town.

OLEACINIDAE

VARICELLA GRACILLIMA FLORIDANA Pilsbry

Varicella gracillima floridana Pilsbry 1907, Man. of Conch., (2)**19**:57 (Key West, Florida).

Varicella gracillima bahamensis Bartsch 1913, Proc. United States National Mus., **46**:109, pl. 3, fig. 13 (Mangrove Cay, Andros Island, Bahamas).

Remarks. This subspecies is quite abundant on Great Inagua, occurring at nearly all stations. Elsewhere in the Bahamas we have found it to be rare. Its abundance may be due to the numerical richness of many other small land mollusks upon which they are supposed to feed.

Specimens examined. GREAT INAGUA: 2, 3½, 4, 6 and 9 miles NE of Matthew Town; 6 miles ENE of Matthew Town; 2 miles SW of Muttonfish Point; Calm Cove; 1 mile SW of Clarkeville (all MCZ); Northeast Point; Salt Pond Hill; Man-o-War Bay; Jackline Hill (all USNM). LITTLE INAGUA: NE of Southwest Point (MCZ).

SAGDIDAE

HOJEDA INAGUENSIS Weinland

Helix inaguensis Weinland 1880, Jahr. Deut. Malako. Gesell., **7**:369, pl. 12, fig. 22 (Little Inagua).

Specimens examined. GREAT INAGUA: 1 mile N; 2, 3½, 4 and 9 miles NE of Matthew Town; 2 and 6 miles E of Matthew Town; 6 miles ENE of Matthew Town; Salt Pond Hill; Calm Cove; Canfield Bay; Kerrline; 2 miles SW of Muttonfish Point; Jackline Hill; 1 mile SW of Clarkeville (all MCZ); center of Ocean Bight; Northwest Point; Conch Shell Point; Man-o-War Bay (all USNM). LITTLE INAGUA: Northwest Point; NE of Southwest Point (both MCZ); bay S of Northwest Point (USNM).

LACTEOLINA SELENINA Gould

Helix selenina Gould 1848, Proc. Boston Soc. Nat. Hist., **3**:38 (Georgia and Florida).

Specimens examined. GREAT INAGUA: 9 miles NE of Matthew Town.

BULIMILIDAE

DRYMAEUS BAHAMENSIS SALINA, new name

Drymaeus bahamensis roseatus Clench 1933, Proc. New England Zool. Club, **13**:87, pl. 1, figs. 12-13 (Great Inagua, Bahamas). New name for *Drymaeus roseatus* Clench 1933, non *Bulimus* [*Drymaeus*] *roseatus* Reeve 1848.

Remarks. McLean and Shreve found only two specimens of this subspecies. The original specimens described in 1933 were collected by Sargent, one of the early collectors on this island. Holotype, Museum of Comparative Zoology, no. 90104.

Specimens examined. GREAT INAGUA: Matthew Town; SE of Grey Well (both MCZ).

UROCOPTIDAE

MICROCERAMUS SWIFTI Bland

Macroceramus swifti Bland 1875, Ann. Lyceum Nat. Hist. New York, **6**:83 (Turks Island, also Inagua, Bahamas).

Remarks. The lectotype, here selected, is in the Museum of Comparative Zoology, no. 189912, from Turks Island, from the Bland collection.

Specimens examined. Great Inagua: 1, 3½, 4, 6 and 9 miles NE of Matthew Town; 1½ miles NNE of Matthew Town; 6 miles ENE of Matthew Town; Conch Shell Point; SE of Grey Well; Jackline; Calm Cove; Kerrline (all MCZ); center of Ocean Bight; Salt Pond Hill (USNM). Little Inagua: Northwest Point; NE of Southwest Point (both MCZ); Southwest Point (USNM).

Gongylostoma bahamensis Pfeiffer

Cylindrella bahamensis Pfeiffer 1861, Malakozoologische Blätter, **7**:214, pl. 2, figs. 8-11 (Nassau, Bahamas).

Remarks. This species is very rare on Great Inagua as only three dead specimens were collected at three different localities.

Specimens examined. Great Inagua: 6 miles ENE of Matthew Town; Maroon Hill (both MCZ); south of Salt Pond Hill (USNM).

CERIONIDAE

It appears to be nearly impossible to assign any real or significant taxonomic limitations for the many forms in this composite group. No two colonies or collections are exactly alike and in many there is an astounding number of variations. Of the several names available we have selected a few to represent the divergent types. On purely nomenclatorial grounds these are presented as "species." In a taxonomic sense they have little value other than to express the extreme variations in the shell morphology.

There are no geographical or even ecological factors of any magnitude to segregate *Cerion* on Great Inagua. Chance and hurricanes have played their part, and man, both early and modern, has probably abetted this confusion.

On purely speculative grounds it is possible that three somewhat diverse species existed originally on this island: a large white form of the *dimidiata* complex, a finely ribbed form of the *eximeum* complex and a form of the *vulneratum* complex having a brownish red coloration. Hybrid elements of all three groups exist in profusion and the numerous characters in various combinations are to be found in the *Cerion* colonies throughout the island. Later a fourth element arrived, of the *scalarinum* complex, which so far has not been found to hybridize with any of the three elements noted above.

CERION (DIACERION) RUBICUNDUM Menke

Pupa rubicunda Menke 1829, Verzeichnis Conchy.-Samml. Malsburg, Pyrmont, p. 8 (no locality given).

Pupa antonii Küster 1847, Conchylien — Cabinet, (2) **1**, pt. 15, p. 92, pl. 10, figs. 7-8 (Berbice, British Guiana). [This is a definite error in locality. Its coloration alone assigns it to Great Inagua.]

Strophia cylindrica Maynard 1896, Contributions to Science, **3**:34, pl. 7, figs. 3-4 (Matthew Town, Inagua, Bahamas).

Pupa bryanti Pfeiffer 1867, Malakozoologische Blätter, **14**:130 (Southern Great Inagua, Bahamas); Pfeiffer 1867, Novitates Conchologicae, (1)**3**:366, pl. 84, figs. 14-15.

Strophia pallida Maynard 1889, Contributions to Science, **1**:70, pl. 2, figs. 14-14a (south shore of Inagua, 15-20 miles from Matthew Town, Bahamas).

Strophia ianthina Maynard 1889, Contributions to Science, **1**:69, pl. 2, figs. 13-13a (south shore of Inagua, 25 miles from Matthew Town, Bahamas).

Strophia orbicularia Maynard 1890, Contributions to Science, **1**, pl. 16, figs. 6a-b (no locality given [Inagua, Bahamas is on the label of the type specimens, MCZ 76408; 76409]).

Cerion duplodon Pilsbry and Vanatta 1896, Proc. Acad. Nat. Sci. Philadelphia, p. 337, pl. 11, fig. 26 (Bahamas).

Cerion bryanti pudicum Pilsbry 1902, Man. of Conch., (2)**14**:273, pl. 46, figs. 17-18 (no locality given [Great Inagua]).

Remarks. The distribution of *C. rubicundum* is limited to the western and southern portions of Great Inagua. It occurs on the coast at Northwest Point south and then east for 25 miles along the south coast. It also occurs inland at least as far as the Lake, the large interior salina.

Specimens examined. GREAT INAGUA: Matthew Town; 1, 1½, and 5½ miles E of Matthew Town; 2½, 4, and 7 miles NE of Matthew Town; island in Salina, 7 miles NE of Matthew Town; 15-20 and 25 miles E of Matthew Town on the south shore; Northwest Point; Kerrline; Maroon Hill; Salt Pond Hill; Jackline (all MCZ).

CERION RUBICUNDUM VIOLA Maynard

Plate 1, figure 2

Strophia viola Maynard 1890, Contributions to Science, Newtonville, Massachusetts, **1**, pl. 16, figs. 5a-b (locality not given). [It is Inagua, Bahamas, on Maynard's type label.]

Cerion rubicundum var. *heterodon* Pilsbry 1902, Man. of Conch., (2)**14**:275, pl. 45, figs. 96-98 (Inagua).

Cerion (*Diacerion*) *inaguense* Clench 1933, Proc. New England Zool. Club, **13**:98, pl. 1, fig. 9 (Northwest Point, Great Inagua, Bahamas).

Specimens examined. GREAT INAGUA: 1 mile SW of Clarkeville; 1 mile N of Middle Point; Blakeville; 2½, 3 and 4 miles E of Matthew Town; 4 miles E of Northwest Point; 1½ miles SE of Matthew Town (all MCZ); Man-o-War Bay (MCZ; USNM).

CERION RUBICUNDUM VALIDUM Pilsbry

Cerion columna valada Pilsbry 1895, Proc. Acad. Nat. Sci. Philadelphia, **47**:207 (Inagua).

Specimens examined. GREAT INAGUA: Halfway between Palmetto and Carmichael Points (Muttonfish and Polacca Points); west side of Northwest Point; east side of Northwest Point (all USNM); Canfield Bay (MCZ).

CERION (DIACERION) DALLI Maynard

Strophia dalli Maynard 1889, Contributions to Science, **1**:128, pl. 16, fig. 1b, text figs. 32-33 (Inagua, Bahamas).

Specimens examined. GREAT INAGUA: 1½, 2 and 5½ miles E of Matthew Town; Northwest Point; Sheep Cay; near Doanes Creek; Conch Shell Point; 2 miles SW of Muttonfish Point; Southwest Point (all MCZ); east side of salt pans; Jackline (both USNM).

CERION (STROPHIOPS) COLUMNA Pilsbry and Vanatta

Cerion columna Pilsbry and Vanatta 1895, Proc. Acad. Nat. Sci. Philadelphia, **47**:207 (Turtle Cove, Great Inagua); Pilsbry 1902, Man. of Conch., (2)**14**:235, pl. 34, figs. 5-7.

Cerion christophei Clench 1937, Proc. New England Zool. Club, **16**:24, pl. 1, fig. 2 (Northeast Point [Christophe's Palace] Great Inagua, Bahamas).

Remarks. The localities given above extend along a 40 mile stretch of northern Great Inagua between Muttonfish Point and Northeast Point. The colonies vary considerably among themselves, especially in size, costation and the extent of coloration within the aperture. Specimens in any one colony are variable, mainly in size. About half of the colonies examined show a pinkish coloration on the early whorls of the spire, indication of a previous infusion of *C. rubicundum* stock.

Specimens examined. GREAT INAGUA: Turtle Cove; Muttonfish Point; Canfield Bay; Calm Cove; Lydia Point; Northeast Point (all MCZ); North Point of Ocean Bight; center of Ocean Bight; east side of lagoon, west coast of north peninsula (all USNM).

CERION (STROPHIOPS) SARCOSTOMUM Pilsbry and Vanatta

Cerion sarcostomum Pilsbry and Vanatta 1896, Proc. Acad. Nat. Sci. Philadelphia, p. 331, pl. 11, fig. 16 (Little Inagua, Bahamas).

Specimens examined. LITTLE INAGUA: 1½ and 2 miles S of Northwest Point (both MCZ); between hill and W shore at S end (USNM).

Remarks. A small race which appears to be this species was collected by Bartsch in 1930 near the SW section of Little Inagua. All of the specimens obtained were dead and many of them appeared to be very old. It is possible that this race of *sarcostomum* is now extinct.

CERION (STROPHIOPS) CALCAREUM Pfeiffer

Pupa calcarea Pfeiffer 1847, Zeitschrift für Malakozoologie, **4**:83 (locality unknown).

Specimens examined. LITTLE INAGUA: Southwest Point; Northwest Point; 2 miles S of Northwest Point (all MCZ); 1 mile N of Southwest Point; midway between West and Southwest Points (both USNM).

CERION (STROPHIOPS) BACONI Bartsch

Cerion (Cyclocerion) baconi Bartsch 1952, Revista de la Sociedad Malacologica, Museo Poey, Univ. de la Habana, **9**:1, text fig. 1 (Northwest Point, Little Inagua, Bahamas).

Remarks. *Cerion baconi* appears to be rather closely related to *C. malonei* Clench of Long Island, Bahamas and more distantly to *C. dimidiatum* Pfeiffer from Gibara, Cuba. The greatest single difference seems to be the exceedingly small size of *C. baconi.*

Specimens examined. LITTLE INAGUA: Northwest Point (USNM).

CERION (UMBONIS) REHDERI Clench and Aguayo

Cerion (Umbonis) rehderi Clench and Aguayo 1952, Occasional Papers on Mollusks (Harvard University), **1**:422, pl. 57, fig. 2 (Jackline, Great Inagua, Bahamas).

Specimens examined. GREAT INAGUA: Jackline, 1 mile W of Conch Shell Point (MCZ; USNM).

CERION (UMBONIS) TURNERAE Clench and Aguayo

Cerion (Umbonis) turnerae Clench and Aguayo 1952, Occasional Papers on Mollusks (Harvard University), **1**:423, pl. 53, figs. 4-7 (Lydia Point, Great Inagua, Bahamas).

Specimens examined. GREAT INAGUA: Lydia Point; S of Northeast Point; Calm Cove; Canfield Bay (all MCZ); North Point of Ocean Bight; S of Northeast Point; E of Salt Lagoon (all USNM).

CERION (UMBONIS) SHREVEI Clench and Aguayo

Cerion (Umbonis) shrevei Clench and Aguayo 1952, Occasional Papers on Mollusks (Harvard University), **1**:436, pl. 57, fig. 4 (near Northwest Point, Little Inagua, Bahamas).

Specimens examined. LITTLE INAGUA: near Northwest Point (MCZ); N of South Point; halfway between West and South Points (both USNM).

CERION (MAYNARDIA) ERICKSONI, new species

Plate 1, figure 1

Description. Shell reaching about 23 mm. (about one inch) in length, attenuate, rimately perforate, solid and strongly sculptured. Color a dull red-brown with the axial costae white. Whorls eight to nine, slightly convex, first six whorls forming a convex summit. Spire extended, the convex summit forming an angle of about 55°. Aperture subcircular. Outer lip reflected, thickened and turned backward to form a collar. Parietal lip thickened but not built forward. Columella short and arched. Columellar tooth very small and extending back for nearly a full whorl. Parietal tooth centered, moderately strong but short. Sculpture consists of rather prominent straight and rather regular, axial costae which number 27 to 30 on the body whorl. There is no trace of spiral sculpture. Nuclear whorls smooth, opaque and glass-like.

Length	*Width*	*Whorls*	
23.2 mm.	10.5 mm.	9	Holotype
21	10.4	9	Paratype
18.2	9.8	8	Paratype

Types. Holotype in the Museum of Comparative Zoology, no. 189121, from Southwest Point, Little Inagua, Bahama Islands, McLean and Shreve collectors, 1938. Paratypes from the same locality in the Museum of Comparative Zoology, the Museo Poey, the United States National Museum, and the Academy of Natural Sciences, Philadelphia.

Remarks. This species is in the *C. glans* Küster complex and closely related to *C. periculosum* Clench from South Cay, Mira Por Vos Group, Crooked Island Bank. It is the first member of this complex to be recorded from the Inaguas. It differs from *periculosum* by being heavier, by having the aperture more circular and by having the axial costae vertical and not inclined backward. In addition, the outer lip is much thicker and is reflected backward for over a millimeter. From *C. blandi* Pilsbry and Vanatta from Turks Island, it differs by being smaller, having more axial ribs and by having a less tapering spire. All three species are closely related.

This species is named for M. M. Erickson of Matthew Town in appreciation of his aid and kindness to the McLean and Shreve party during their stay on Great Inagua.

CERION ALVEARIUM Dillwyn

Turbo alvearia Dillwyn 1817, Descriptive Catalogue of Recent Shells, **2**:862 (Santo Domingo and Guadeloupe).

This species has been recorded from Great Inagua by both J. J. Brown and C. M. Poulsen. The brief original description and the references to the figures in Lister and Seba are impossible to recognize.

FRUTICICOLIDAE

HEMITROCHUS GALLOPAVONIS Pfeiffer

Helix gallopavonis 'Valenciennes' Pfeiffer 1842, Symbolae ad Historiam Heliceorum, **2**:28 (St. Croix; Turks Island).

Helix constantior Weinland 1880, Jahr. Deut. Malak. Gesell., **7**:371, pl. 12, fig. 19 (Inagua; Rum Cay; Turks Island, Bahamas).

Helix xanthophes Pilsbry 1891, Nautilus, **5**:83 (Inagua).

Remarks. This is the only species of *Hemitrochus* existing on Great and Little Inagua Islands. Several other specific names have been used but all appear to be misidentifications, based upon this single species.

Helix xanthophes Pilsbry is nothing but a small, brown and partially grown specimen of *gallopavonis*. Most of the specimens possess one or more spiral bands of brown and on many specimens the bands are interrupted or spotted. In others, these bands widen out and occasionally completely color the entire shell. We possess additional specimens of this species from Castle, Mariguana, Long, Turks and Caicos Islands.

Specimens examined. GREAT INAGUA: Northeast Point; Sheep Cay; Canfield Bay; Lydia Point; Matthew Town; Calm Cove; Conch Shell Point; Jackline; 4 miles E of Matthew Town (all MCZ); Carmichael Point; 8 miles W of Canfield Bay (both USNM). LITTLE INAGUA: Northwest side (MCZ).

PLAGIOPTYCHA SARGENTI Bland

Plate 1, figure 3

Helix sargenti Bland 1875, Ann. Lyceum Nat. Hist. New York, **11**:79 (Little Inagua, Bahamas).

Remarks. A lectotype, here selected, of this species is in the Museum of Comparative Zoology, no. 88104, originally in the T. Bland collection.

This species has been found recently by George R. Proctor at Sapodilla Bay, Providentiales Island, Caicos Islands. The specimens were dead and appeared to be very old and may now be extinct in these islands.

Specimens examined. LITTLE INAGUA: $1\frac{1}{2}$ miles S of Northwest Point; NE of Southwest Point (both MCZ); 1 mile N of South Point (USNM).

PLAGIOPTYCHA MACROGLOSSA Pfeiffer
Plate 1, figure 8

Helix macroglossa Pfeiffer 1866, Malakozoologische Blätter, **13**:115 (Great Inagua, Bahamas).

Remarks. A lectotype, here selected, of this species is in the Museum of Comparative Zoology, no. 90308, from Great Inagua. This specimen was originally in the T. Bland collection.

Specimens examined. GREAT INAGUA: Matthew Town; 2 miles NE of Matthew Town; Lantern Head; 1 mile W of Conch Shell Point; Northwest Point; Maroon Hill; near Muttonfish Point (all MCZ).

PLAGIOPTYCHA INAGUANA Dall
Plate 1, figure 4

Cepolis (*Plagioptycha*) *inaguana* Dall 1905, [in] The Bahama Islands, ed. by G. B. Shattuck, The Geographic Soc. of Baltimore, p. 38, pl. 12, fig. 1; pl. 13, fig. 2 (Inagua Island).

Remarks. This species has been referred to *Plagioptycha albersiana* Pfeiffer. The latter was described as coming from Santo Domingo, originally collected by A. Sallé. We have a series of heautotypes from the Bland collection determined by Pfeiffer as *albersiana* and collected on Great Inagua by Miller. It is perhaps best, however, to retain Dall's name until more critical material is at hand from Santo Domingo, or authentic *albersiana* collected by Sallé is located for comparison. The holotype of *P. inaguana* is in the United States National Museum, no. 105793, from Great Inagua, originally contained in the Lea collection.

Specimens examined. GREAT INAGUA: Matthew Town; 4 miles E of Matthew Town; 6 miles NE of Matthew Town; Calm Cove; 1 mile W of Conch Shell Point; Lydia Point; Canfield Bay; Southwest Point (all MCZ); Jackline; 2 miles S of Northwest Point; center of Ocean Bight; Northeast Point (all USNM).

SPHAERIIDAE

Eupera bahamensis Clench

Byssanodonta bahamensis Clench 1938, Bull. Museum of Comparative Zoology, **80**:535, pl. 2, fig. 6 (Arthurs Town, Cat Island).

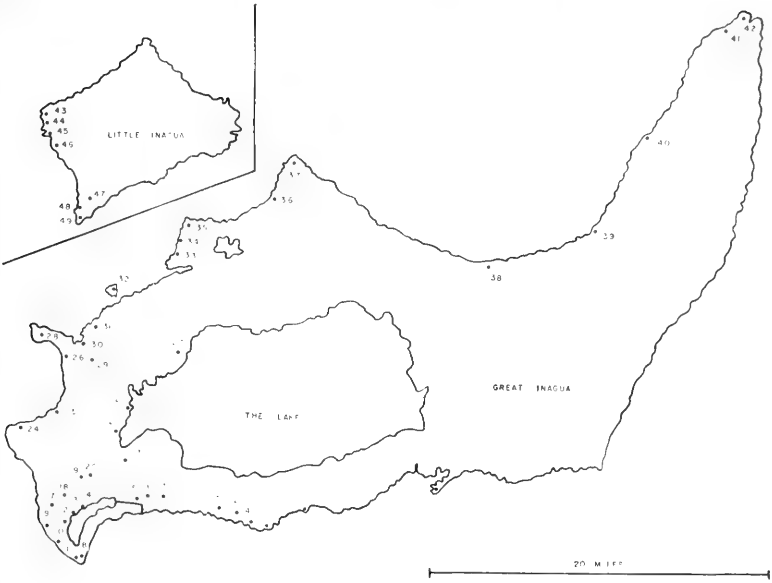
Specimens examined. Great Inagua: 1½ miles southeast of Grey Well.

GREAT INAGUA

South Coast
1 Lantern Head
2 Near Doan's Creek
3 Conch Shell Point
4 1 mile W of Conch Shell Point
5 Jackline
6 Kerrline
7 Salt Pond Hill
8 Southwest Point
Matthew Town And Vicinity
9 Matthew Town
10 1½ miles SE of Matthew Town
11 3 miles SE of Matthew Town
12 1 mile E of Matthew Town
13 1½ miles E of Matthew Town
14 2 miles E of Matthew Town
15 5½ miles E of Matthew Town
16 6 miles E of Matthew Town
17 Horse Pond, 1 mile NE of Matthew Town
18 2 miles NE of Matthew Town
19 3½ miles NE of Matthew Town
20 4 miles NE of Matthew Town
21 7 miles NE of Matthew Town
22 9 miles NE of Matthew Town
23 6 miles ENE of Matthew Town
West Coast
24 1 mile N of Middle Point
25 1 mile SW of Clarkeville
26 Man-o-War Bay
27 Maroon Hill
28 Northwest Point
29 1½ miles SE of Grey Well
30 Grey Well
31 E end of Salt Pond
32 Sheep Cay
33 Mangle Bush
34 2 miles SW of Muttonfish Point
35 Muttonfish Point (= Palmetto Point)
36 Turtle Cove
37 Polacca Point (= Carmichael Point)
North Coast
38 Ocean Bight
39 Canfield Bay
40 Lydia Point
41 Calm Cove
42 Northeast Point

LITTLE INAGUA

43 Northwest Point
44 Bay S of Northwest Point
45 1½ miles S of Northwest Point
46 2 miles S of Northwest Point
47 NE of Southwest Point
48 1 mile N of Southwest Point
49 Southwest Point



Collecting localities on Great and Little Inagua[3]

* * * *

REFERENCES

Bryant, H.

1866. Additions to a List of Birds seen at the Bahamas. Proc. Boston Soc. Nat. Hist., **11:** 63-70.

Clench, W. J.

1938. Origin of the Land and Freshwater Mollusk Fauna of the Bahamas, with a List of the Species Occurring on Cat and Little San Salvador Islands. Bull. Mus. Comp. Zool., **80:** 481-541, 3 pls.

1952. Land and Freshwater Mollusks of Eleuthera Island, Bahama Islands. Rev. Soc. Malac. "Carlos de la Torre," **8:** 97-116, 2 pls.

1952. The Scalarinum Species Complex (Umbonis) in the Genus Cerion. Occ. Pap. Moll., Harvard Univ., **1:** 413-440, 7 pls.

1957. A catalogue of the Cerionidae (Mollusca-Pulmonata). Bull. Mus. Comp. Zool., **116:** 121-169.

Turner, R. D.

1957. Charles Johnson Maynard and his Work in Malacology. Occ. Pap. Moll., Harvard Univ., **2:** 137-152, 1 pl.

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[3] Lantern Head is the little peninsula just right of center, south coast.

Fig. 1. *Cerion ericksoni* Clench. Southwest Point, Little Inagua, Bahama Islands. Holotype MCZ 189121. 2.9X

Fig. 2. *Cerion rubicundum viola* Maynard. Great Inagua, Bahama Islands. Holotype MCZ 76407. 2.9X

Fig. 3. *Plagioptycha sargenti* Bland. Little Inagua, Bahama Islands. Lectotype MCZ 88104. 2.7X

Fig. 4. *Plagioptycha inaguana* Dall. Great Inagua, Bahama Islands. Holotype USNM 105793. 3X

Fig. 5. *Eutrochatella klinei* Clench. Northeast of Southwest Point, Little Inagua, Bahama Islands. Holotype MCZ 189603. 7X

Fig. 6. *Chondropoma biforme* Pfeiffer. Turks Islands, Bahama Islands. Lectotype MCZ 78149. 3.1X

Fig. 7. *Chondropoma rawsoni* Pfeiffer. Great Inagua, Bahama Islands. Lectotype MCZ 90131. 3.7X

Fig. 8. *Plagioptycha macroglossa* Pfeiffer. Great Inagua, Bahama Islands. Lectotype MCZ 90308. 2.7X

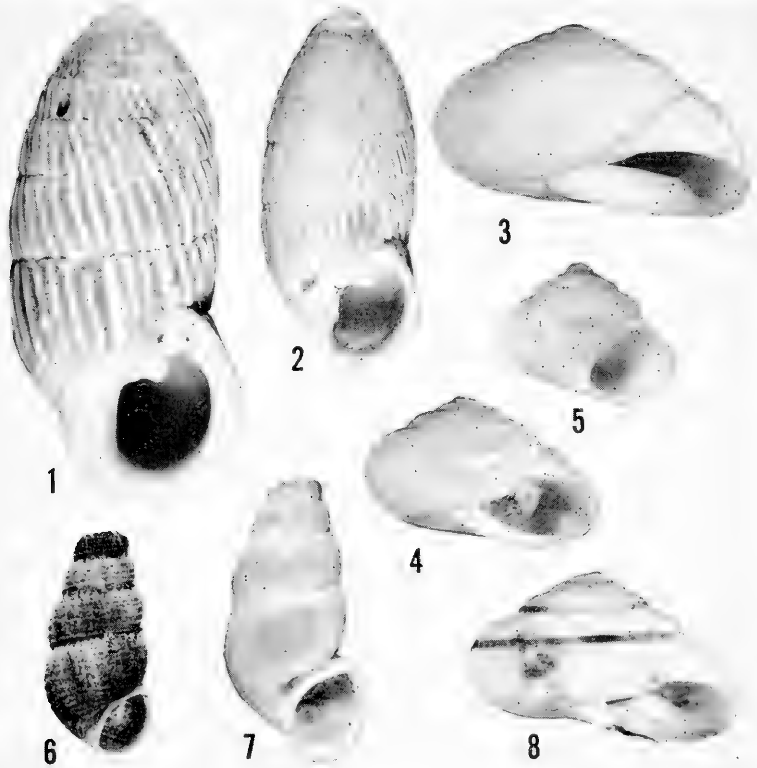

PLATE 1

Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE

Vol. 121, No. 3

THE SPIDER GENERA *ACHAEARANEA*, *THERIDION* AND *SPHYROTINUS* FROM MEXICO, CENTRAL AMERICA AND THE WEST INDIES. (ARANEAE, THERIDIIDAE)

By Herbert W. Levi

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
July, 1959

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MUSEUM OF COMPARATIVE ZOOLOGY AT HARVARD COLLEGE

Bulletin (octavo) 1863 — The current volume is Vol. 121.

Breviora (octavo) 1952 — No. 111 is current.

Memoirs (quarto) 1864–1938 — Publication was terminated with Vol. 55.

Johnsonia (quarto) 1941 — A publication of the Department of Mollusks. Vol. 3, no. 38 is current.

Occasional Papers of the Department of Mollusks (octavo) 1945 — Vol. 2, no. 22 is current.

Proceedings of the New England Zoological Club (octavo) 1899–1948 — Published in connection with the Museum. Publication terminated with Vol. 24.

The continuing publications are issued at irregular intervals in numbers which may be purchased separately. Prices and lists may be obtained on application to the Director of the Museum of Comparative Zoology, Cambridge 38, Massachusetts.

Of the Peters "Check List of Birds of the World," volumes 1-3 are out of print; volumes 4 and 6 may be obtained from the Harvard University Press; volumes 5 and 7 are sold by the Museum, and future volumes will be published under Museum auspices.

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No. 3 — *The Spider Genera Achaearanea, Theridion and Sphyrotinus from Mexico, Central America and the West Indies.* (*Araneae, Theridiidae*)

By Herbert W. Levi

In two previous papers (1956, Amer. Mus. Novitates, no. 1718; 1957, Bull. Amer. Mus. Nat. Hist., vol. 112, no. 1). I revised the spiders of the genera *Achaearanea, Theridion* and *Sphyrotinus* from North America, except Mexico. The theridiid spider fauna south of the United States is little known and relatively few species have been described. Of the 174 species known to occur in the region (32 *Achaearanea*, 110 *Theridion*, 32 *Sphyrotinus*), 98 are newly described in this paper. These numbers probably represent less than half the total fauna of the region. As a result of the very incomplete knowledge, some species described in this paper are expected to fall into synonymy when males and females can be matched, or when it is found that two allopatric forms intergrade.

This paper is based mainly on the collection in the Museum of Comparative Zoology, the large Panamanian and Jamaican collection of Prof. A. M. Chickering, and the collection of the American Museum of Natural History made available to me by Dr. W. J. Gertsch. I extend my sincere thanks to Dr. Chickering and Dr. Gertsch, and also to Mr. E. Browning and Dr. G. Owen Evans of the British Museum (Natural History) for supplying me with specimens from the Cambridge collection and with specimens from St. Vincent Island, determined by Simon. Others who helped were Dr. A. F. Archer and Dr. R. V. Chamberlin. Dr. J. V. Scorza sent some specimens examined by Caporiacco from Venezuela. Mr. A. Riedel and Prof. T. Jaczewski sent specimens from the Polish Academy of Sciences on loan. A grant from the National Science Foundation (G-4317) made it possible for me to draw the genitalia of several types in European museums, although time during the trip did not permit complete redescription. Research and publication were in part supported by National Institute of Health grant no. E-1944.

The species determined by N. Banks from Costa Rica and Panama were re-examined; however, little reference is made to his publications, since the majority of his specimens had been misidentified.

Several far-ranging species, particularly of the genus *Sphyrotinus*, appear to be polytypic, and show geographical variation. Drawings were made only of the extreme forms, as illustrations of all intermediates could not have been published. The genitalia of spiders vary considerably, and in our modern understanding of the nature of animal species, these differences are recognized to be within the genetic variability of the species, in accord with the evidence of large series available for many species of spiders. Of course, if work is to proceed in spite of limited material, there will be unavoidable errors on the side of "lumping" or "splitting."

In a recent paper, R. Braun (1956, Zeitschr. wissenschaftl. Zool., vol. 159, p. 255-318) describes the way in which, after mating, the male theridiid spider covers the epigynum with secretions from his mouthparts, forming the "Begattungszeichen." This epigynal plug is found also in some other families of spiders. The plug is often difficult or impossible to remove and if only few specimens are available it often is a matter of judgment whether the epigynum is covered or not. It is of interest that in one species, *Theridion galerum* (of which females both with and without plugs were available), the plug was drawn out into a cone of varying length (Fig. 84).

To determine females of these genera it is often essential to examine the internal genitalia. In some species this can be done by dropping the specimen in clove oil for a minute or two. In others the epigynum has to be lifted up at the side with a fine needle, taking care not to remove the whole epigynum. Sometimes the two techniques must be combined. The left palpi are illustrated. Unless indicated otherwise, they are in ventral view.

Zoogeography. Our incomplete knowledge of the species makes it very difficult to summarize distribution patterns. All three genera are probably cosmopolitan. Relatively few species of the *Theridion murarium* group are found in Central America and the West Indies, but they are widespread and especially abundant in southwestern United States and Mexico. The *T. frondeum* group is represented by many species, most of them in Mexico, others widespread. A large heterogeneous assemblage of species has the abdomen wider than long; most are southern Mexican and Central American. The *T. moctezuma* group, one of the largest, is mainly Central American and southern Mexican in distribution and the species seem to be very localized.

The number of species of *Sphyrotinus* is greatest in Central America. While Central American *Sphyrotinus* species probably also live in litter, it is interesting that none is as heavily sclerotized as several species occurring in the United States.

It may be worth while to make a comparison of the fauna of Florida, Jamaica and Panama. Jamaica and Panama are the only areas from which large collections have been examined. The Panamanian theridiids are less well known than the Jamaican ones as the only areas collected are in the vicinity of the Canal Zone.

Florida has 6 *Achaearanea*, 17 *Theridion*, and 4 *Sphyrotinus*
Jamaica has 2 *Achaearanea*, 10 *Theridion*, and 1 *Sphyrotinus*
Panama has 14 *Achaearanea*, 42 *Theridion*, and 15 *Sphyrotinus*

Jamaica has two species of *Achaearanea;* of the two, one (*anna*) is endemic, the other (*porteri*) is found in southeastern United States and Mexico. *Sphyrotinus guanicae* (Map 6) is found in northern Mexico and the Greater Antilles. Two species of Jamaican *Theridion* are endemic (*jamaicense; clemens*), the latter found just in the Blue Mountains; both are very distinct. *Theridion jamaicense* has an affinity with *antillanum,* found only in the Greater and Lesser Antilles (Map 4). Four species (*positivum; crispulum; atropunctatum; hispidum,* Map 3) are found from the southern United States or Mexico to northern South America; two are found in the southern United States (*myersi; submissum*), the latter in the Southwest, but not in Florida. One species is found in the Bahama Islands, Lesser Antilles and Central America (*dilucidum,* Map 2); however, it belongs to a northern group of *Theridion.* Except for the two endemic species Jamaican *Theridion* show strong affinities to the nearctic fauna, none with the Central American.

Panama has five Central American species of *Achaearanea* (*apex; schneirlai; zonensis; machaera; oblivia*). Of two Mexican (*florendida; picadoi*) the latter may be cosmotropical. Three are known also from South America (*taeniata; hirta,* Map 1; *trapezoidalis*). One is Mexican and Cuban (*mesax*). Three are West Indian (*florens; terex; maricaoensis*), the first two found also in Cuba, the last in Puerto Rico. There are seven Central American species of *Sphyrotinus,* (*chickeringi; reservatus; insignis; notabilis; bogus; prolatus; indicatus*). Six are found in Mexico and Central America (*illudens; delicatulus; maderae; confraternus; boquete; deprus*). Two are found in South America or Lesser Antilles (*stylifrons; luculentus*).

Twenty-six Panamanian species of *Theridion* are known only from Central America, two are cosmotropical (*rufipes; adamsoni*), six are Mexican (*adjacens,* Map 4; *niveum; trepidum; elisabethae; nudum; dotanum*), one West Indian and Lesser Antilles (*dilucidum,* Map 2); three are Mexican, West Indian and South American (*atropunctatum; hispidum,* Map 3; *evexum,* Map 5). One has a distribution from Mexico to South America (*grecia*). Three are South American or Lesser Antillean (*sexmaculatum; petrum; minutissimum*).

To summarize: Jamaica has the poorest fauna and the species are predominantly nearctic. Panama is the richest and the spiders are predominantly endemic or possibly South American. Unfortunately little is known of South American species at the present time.

ACHAEARANEA Strand

Like *Theridion, Achaearanea* lacks a colulus. The abdomen is usually higher than long, sometimes modified, and often having a typical pattern of stripes quite distinct from *Theridion.* The palpus of *Achaearanea* is simpler than that of *Theridion;* it always lacks a radix and the median apophysis, if present, is joined to the embolus.

The following species have been misplaced: *Achaea luculenta* Bryant, 1940 = *Chrysso albomaculata* O. P. Cambridge. *A. globosa* (Hentz) was erroneously reported from Cuba by Bryant (1940, Bull. Comp. Zool., vol. 86, p. 319). The specimen had been misidentified. The following well illustrated *Achaearanea* (described as *Theridion*) are found in this region but were not examined:

A. aztecum (Chamberlin and Ivie), 1936, Bull. Univ. Utah, biol. ser., vol. 27, no. 5, p. 34, figs. 97-98, ♂, (♂ type from near Chilapa, Guerrero, in the American Museum of Natural History).

A. boqueronicum (Kraus), 1955, Abhandl. Senckenbergischen Naturf. Gesell., no. 493, p. 17, figs. 37-39, ♀ (♀ type from Dept. La Libertad, El Salvador in the Senckenberg Museum).

A. salvadorense (Kraus), 1955, *op. cit.*, p. 17, figs. 34-36, ♀ (♀ type from San Salvador, El Salvador in the Senckenberg Museum).

Species of *Achaearanea* found in this region and also occurring north of Mexico, illustrated in a previous paper (1955, Amer. Mus. Novitates, no. 1718), are:

ACHAEARANEA SCHULLEI (Gertsch and Mulaik)

Achaearanea schullei, Levi, 1955, p. 17, figs. 32-38, ♀, ♂.

Distribution. Florida to California, south to Guerrero.

Additional records. Puebla: Tehuacán. *Morelos:* Cocoyoc; Cuernavaca. *Querrero :* 11 mi. W. of Chilpancingo.

ACHAEARANEA INSULSA (Gertsch and Mulaik)

Achaearanea insulsa, Levi, 1955, p. 19, figs. 41-45, ♀, ♂.

Distribution. Texas, Tamaulipas, San Luis Potosí.

ACHAEARANEA PORTERI (Banks)

Achaearanea porteri, Levi, 1955, p. 30, figs. 71-75, 80-82, ♀, ♂.

Theridion portoricense Petrunkevitch, 1930, Trans. Connecticut Acad. Sci., vol. 30, p. 197, figs. 42, 43, ♀ (♀ type from cave at Aguas Buenas, Puerto Rico, probably lost). NEW SYNONYMY.

Distribution. Southeastern United States, south to Panama, Bahama Isl., Puerto Rico, Jamaica, often in caves.

Additional records. Tlaxcala: Tlaxcala. *Puebla:* Tehuacán. *Michoacan:* Zamora. *Guerrero:* 7 mi. S. of Chilpancingo. *Costa Rica:* La Verbena (Tristan). *Jamaica:* N. of Flat Bridge, Río Cobre Gorge, St. Catherine (A. F. Archer); Guanoboa Vale, St. Catherine Par. (A. M. Chickering).

ACHAEARANEA TEPIDARIORUM (C. L. Koch)

Achaearanea tepidariorum, Levi, 1955, p. 32, figs. 69-70, 83-84, ♀, ♂.

Distribution. Cosmopolitan. Southern Canada to South Amer-

Indies, although a specimen marked "W. India," 1852, Keyserling is in the Museum of Comparative Zoology. No records from southern Mexico and Central America.

Achaearanea anna, new species

Figures 13-15

Type. Male holotype from St. Ann Parish, Jamaica, British ica. Common in Bermuda, but apparently absent in the West West Indies, June 22, 1954, in the Museum of Comparative Zoology.

Description. Female: Carapace, sternum, legs yellow-white. Abdomen white. Eyes subequal in size, or anterior medians slightly larger. Anterior median eyes one diameter apart, almost touching laterals. Posterior median eyes one diameter apart, two-thirds from laterals. Abdomen very high. Total length 1.3 mm. Carapace 0.65 mm. long, 0.49 mm. wide. First femur, 0.88 mm.; patella and tibia, 0.76 mm.; metatarsus, 0.52 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.55 mm.; third, 0.42 mm.; fourth, 0.56 mm.

Male: Coloration like female except for abdomen which has a white transverse ring around highest portion like *A. conjuncta*. Total length 1.4 mm. Carapace 0.65 mm. long, 0.52 mm. wide. First femur, 1.12 mm.; patella and tibia, 1.04 mm.; metatarsus, 0.82 mm.; tarsus, 0.44 mm. Second patella and tibia 0.75 mm.; third, 0.45 mm.; fourth, 0.61 mm.

Diagnosis. The shape of the palpal cymbium (Fig. 13) and the posterior light area in the swollen part of the epigynum (Fig. 15) distinguish this species from *A. conjuncta*.

Records. Jamaica. E. of May Pen, St. Catherine Par., Nov. 1957, ♀ (A. M. Chickering); Liguanea, St. Andrew Par., Nov. 1957, ♀ (A. M. Chickering).

Achaearanea turquino, new species

Figures 1-3

Type. Female holotype from Pico Turquino, 1500 ft., Cuba, June 25, 1936 (P. J. Darlington), in the Museum of Comparative Zoology.

Description. Carapace, sternum brown. Legs white with brown rings. Abdomen spotted black, brown, reddish; a small white spot on each side of dorsum near highest point. Posterior portion of abdomen white. Eyes subequal in size. Anterior median eyes one diameter apart, one quarter from laterals. Posterior median eyes one diameter apart, less than one from laterals. Abdomen higher than long, like *Achaearanea porteri,* having a tubercle. Total length 2.9 mm. Carapace 0.98 mm. long, 0.85 mm. wide. First femur, 1.30 mm.; patella and tibia, 1.25 mm.; metatarsus, 0.99 mm.; tarsus, 0.50 mm. Second patella and tibia, 0.82 mm:; third, 0.68 mm.; fourth, 1.00 mm.

Diagnosis. The small opening on a cone-shaped elevation of the epigynum (Figs. 2, 3) distinguishes this species from other *Achaearanea.*

Records. Cuba: Sierra de Casas, Isla de Piños, Aug. 17, 1955 (A. F. Archer); Pan de Palenque, Matanzas, Aug. 11, 1955 (A. F. Archer).

ACHAEARANEA HERMOSILLO, new species

Figures 4-8

Type. Male holotype from 66 miles north of Hermosillo, Sonora, Mexico, June 22, 1939 (A. M. and L. I. Davis), in the American Museum of Natural History.

Description. Female: Carapace, sternum dark dusky brown, sometimes reddish around eyes. Legs reddish brown. Abdomen black with pairs of white spots on the posterior side (Fig. 8). Eyes subequal in size; posterior medians separated by one diameter, by one-third from laterals. Height of clypeus equaling one and one-half diameters of anterior median eyes. The epigynum (Fig. 5) is flatter than that of *A. globosa* (Hentz). Total length 1.6-1.9 mm. The allotype measured total length: 1.9 mm. Carapace 0.74 mm. long; 0.65 mm. wide. First femur, 1.30 mm.; patella and tibia, 1.09 mm.; metatarsus, 0.83 mm.; tarsus, 0.48 mm. Second patella and tibia, 0.80 mm.; third, 0.56 mm.; fourth, 0.82 mm.

Male: Coloration and structure like that of female. The anterior median eyes are slightly larger than the others. The abdomen is almost as high as long with the dorsolateral extensions less distinct. Palpus illustrated by Figures 6, 7. Total length 1.9 mm. Carapace 0.94 mm. long, 0.73 mm. wide. First femur, 1.62 mm.; patella and tibia, 1.57 mm.; metatarsus, 1.13 mm.;

tarsus, 0.57 mm. Second patella and tibia, 1.04 mm.; third, 0.68 mm.; fourth, 0.90 mm.

Diagnosis. The abdominal humps and the genitalia distinguish this species from *A. globosa* (Hentz).

Record. Sonora: 66 mi. N. of Hermosillo, ♀ allotype, 2 ♀ paratypes, June 22, 1939 (A. M. and L. I. Davis).

ACHAEARANEA APEX, new species

Figures 9-12

Type. Male holotype from Summit, Canal Zone, July 24-29, 1950 (A. M. Chickering) in the Museum of Comparative Zoology.

Description. Female: Carapace black. Sternum white, with a rusty patch near posterior end. Legs white with wide dark bands on middle and distal ends of segments; patellae black. Dorsum of abdomen black with white spots; venter black behind genital groove, lighter in the middle. From sides of white epigastric plates are white bands going dorsal (Fig. 11). Anterior median eyes one-third to one-half a diameter apart, one-fourth from laterals. Posterior median eyes three-quarters diameter apart, one-third from laterals. Epigynum (Fig. 10) with opening anterior to a swollen area. Total length 1.6-1.8 mm. One specimen total length: 1.8 mm. Carapace 0.68 mm. long, 0.60 mm. wide. First femur, 0.78 mm.; patella and tibia, 0.78 mm.; metatarsus, 0.52 mm.; tarsus, 0.32 mm. Second patella and tibia, 0.61 mm.; third, 0.45 mm.; fourth, 0.74 mm.

Male: Carapace dusky yellow; sternum, legs yellow. Abdomen grayish white with a more or less distinct white dorsal cross band across middle; anterior of cross band are about four white spots; posterior to it some fine black pigment spots and white spots. Palpus illustrated by Figure 12. Total length, 1.3 mm. Carapace, 0.58 mm. long, 0.52 mm. wide; first femur, 0.89 mm.; patella and tibia, 0.78 mm.; metatarsus, 0.61 mm.; tarsus, 0.39 mm. Second patella and tibia, 0.62 mm.; third, 0.47 mm.; fourth, 0.65 mm.

Diagnosis. The structure of the cymbium of the male palp (Fig. 12), as well as the female genitalia (Figs. 9, 10) and epigynum differentiate this species from others.

Records. Canal Zone: Summit, ♀ allotype, 4 ♀, 3 ♂ paratypes, Barro Colorado Island.

ACHAEARANEA FLORENS (O. P. Cambridge)
Figures 16, 18-19

Theridion florens O. P. Cambridge, 1886, Biologia Centrali Americana, Araneidea, vol. 1, p. 205, pl. 24, fig. 12, ♀ (♀ type from Tabasco, Mexico, in the British Museum, Natural History).

Achaea mendax O. P. Cambridge, 1899, *op. cit.*, p. 294, pl. 39, fig. 7, ♂. F. P. Cambridge, 1902, *ibid.*, vol. 2, p. 401, pl. 37, fig. 30, ♂. (♂ type from Coban, Guatemala, in the British Museum, Natural History).

Steatoda florens, F. P. Cambridge, 1902, *op. cit.*, p. 382, pl. 36, figure 5, ♀.

Achaearanea florens, Levi, 1955, Amer. Mus. Novitates, no. 1718, p. 15 (in part), figs. 26-29, ♀, ♂, (not figs. 30-31).

Diagnosis. This species is very close to *A. florendida* with which I confused it in a previous paper (Levi, 1955). The genitalia of both species have been illustrated at the same magnification. The cymbium of the palpus of *A. florens* (Fig. 16) is more slender near its tip than that of *A. florendida* (Fig. 17). The epigyna of the two species are similar (Figs. 19, 21); however, the total length of females of *A. florens* is 2.6-4.7 mm., that of *A. florendida* is only 1.8-2.6 mm. Most of females can therefore be readily separated by size. (The males are of more equal size, those of *A. florens* being between 1.8-2.2 mm. total length.)

Natural History. The eggsac of this species has been found in a rolled up leaf.

Records. Distrito Federal: Mexico. *Costa Rica:* Tejar de Cartago (Biolley and Tristan); Fortuna (Tristan). *Panama:* Boquete; El Volcán (A. M. Chickering). *Canal Zone:* Barro Colorado Isl. (many records). *Cuba:* Soledad, Vilcher's Hill (L. S. Worley); 7 mi. S. of Hidalgo.

ACHAEARANEA FLORENDIDA, new species
Figures 17, 20-21

Achaearanea florens, Levi, 1955, Amer. Mus. Novitates, no. 1718, p. 15 (in part), figs. 30-31, ♂ (not figs. 26-29).

Type. Male holotype, from Barro Colorado Island, Canal Zone, Aug. 1-6, 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Female: carapace, sternum, legs, yellow-white; legs slightly dusky at ends of segments. Abdomen with pattern as in *A. florens,* but lighter. Eyes subequal in size, three-quarters diameter apart, one-quarter diameter from laterals. Posterior eyes separated by two-thirds diameter. Total length 1.8-2.4 mm. Allotype total length, 2.0 mm. Carapace, 0.85 mm. long, 0.71 mm. wide. First femur, 1.43 mm.; patella and tibia, 1.30 mm.; metatarsus, 1.17 mm.; tarsus, 0.55 mm. Second patella and tibia, 0.91 mm.; third, 0.65 mm.; fourth, 0.96 mm.

Male: Lighter colored and yellower than female. Total length, 1.4-1.8 mm. Holotype total length, 1.4 mm. Carapace, 0.85 mm. long; 0.66 mm. wide. First femur, 1.53 mm.; patella and tibia, 1.36 mm.; metatarsus, 1.22 mm.; tarsus, 0.53 mm. Second patella and tibia, 0.99 mm.; third, 0.63 mm.; fourth, 0.85 mm.

Diagnosis. The cymbium of the male palp has a stouter tip (Fig. 17) than *A. florens.* The females are smaller in size than those of *A. florens.* The epigyna are similar.

Records. Texas: (Levi, 1955). *Tamaulipas:* 27 mi. N. of Villa Juárez. *Costa Rica:* San José. *Panama:* El Valle; Boquete. *Canal Zone:* Barro Colorado Isl, ♀ allotype, ♀, ♂ paratypes (very common); Summit, Chilibre; Chiva Rd. nr. Pedro Miguel.

ACHAEARANEA SERAX, new species

Figures 22-23

Type. Female holotype from Finca Cuauhtémoc near Cacahuatán, Chiapas, August 3-13, 1950 (C. and M. Goodnight), in the American Museum of Natural History.

Description. Female: Coloration as in *A. florens.* Eyes subequal in size; posterior medians separated by three-fourths diameter from each other, by two-thirds from laterals. Total length 2.5 mm. Carapace, 0.94 mm. long, 0.78 mm. wide. First femur, 1.56 mm.; patella and tibia, 1.45 mm.; metatarsus, 1.29 mm.; tarsus, 0.59 mm. Second patella and tibia, 0.95 mm.; third, 0.66 mm.; fourth, 1.10 mm.

Diagnosis. This species differs from *A. florens* and *A. florendida* by the much larger openings of the epigynum (Fig. 23).

Record. Chiapas: Finca Cuauhtémoc nr. Cacahuatán, ♀ paratype (C. and M. Goodnight); Tenejapa (C. Goodnight).

ACHAEARANEA NAYARITENSIS, new species
Figures 67-69

Type. Female type from La Mesa de Nayarit, Nayarit, July 16-21, 1955 (B. Malkin), in the American Museum of Natural History.

Description. Carapace whitish, cephalic portion with a black band covering eyes in front and narrowing towards thoracic depression; margin with a black line. Sternum dark brown. Legs with dark brown bands, as wide as intermediate white areas. Abdomen spotted brown, black and white with a typical pattern. Anterior median eyes one diameter apart, almost touching laterals. Posterior median eyes their radius apart, two-thirds diameter from laterals. Total length 2.0 mm. Carapace 0.95 mm. long, 0.79 mm. wide. First femur 1.50 mm.; patella and tibia, 1.36 mm.; metatarsus, 1.14 mm., tarsus, 0.52 mm. Second patella and tibia, 1.01 mm.; third, 0.78 mm.; fourth, 1.20 mm.

Diagnosis. A lighter bulge in the center of the epigynum (Figs. 68, 69) separates this species from others.

ACHAEARANEA SCHNEIRLAI, new species
Figure 26

Type. Male holotype from Barro Colorado Island, Panama, April 30, 1946 (T. C. Schneirla), in the American Museum of Natural History.

Description. Male: Carapace red-brown. Sternum reddish brown, dusky around margin. Coxae very light; legs with brown bands, more distinct on distal segments. Dorsum of abdomen with black and white spots, anterior mostly dark, venter black. Anterior median eyes slightly larger than others; posterior median eyes separated by one diameter, by two-thirds from laterals. Height of clypeus equals one and one-half diameters of anterior median eyes. Abdomen without tubercle, quite hairy. Total length 1.8 mm. Carapace, 0.88 mm. long, 0.78 mm. wide. First femur, 1.36 mm.; patella and tibia, 1.30 mm.; metatarsus, 0.91 mm.; tarsus, 0.49 mm. Second patella and tibia, 0.91 mm.; third, 0.66 mm.; fourth, 0.96 mm. This species might be the male of *A. schraderorum.*

Diagnosis. The long thread-like embolus of the palpus (Fig. 26) distinguishes this species from *A. aztecum.*

ACHAEARANEA SCHRADERORUM, new species
Figures 24-25

Type. Female holotype from Siquirres, Costa Rica, May 20-23, 1944 (Dr. and Mrs. F. Schrader), in the American Museum of Natural History.

Description. Female: Carapace dark brown. Sternum red-brown, coxae dusky. Legs white with red-brown bands. Abdomen gray with several white lines and spots. Eyes subequal in size; posterior median eyes separated by two-thirds their diameter and by the same distance from laterals. Height of clypeus equals two diameters of anterior median eyes. No tubercle on the abdomen. The epigynum (Fig. 25) is a large depression and has a slight notch at the posterior border. Total length 1.9 mm. Carapace, 0.82 mm. long; 0.70 mm. wide. First femur, 1.20 mm.; patella and tibia, 1.09 mm.; metatarsus, 0.78 mm.; tarsus, 0.44 mm. Second patella and tibia, 0.75 mm.; third, 0.55 mm.; fourth, 0.82 mm.

Diagnosis. The epigynum (Fig. 25) distinguishes this species.

ACHAEARANEA TRINIDENSIS, new species
Figures 29-31

Type. Male type from Simla, near Arima, Trinidad, Dec. 28, 1954 (A. M. Nadler), in the American Museum of Natural History.

Description. Carapace, sternum, legs light yellow; sternum dusky behind. Abdomen of female with a white cross band anterior of dorsum and a central white stripe; venter with a dusky mark anterior to spinnerets. Male darker, abdomen with patches of black pigment. Anterior median eyes much larger than others, one and a half diameters of posterior medians in female, one and three-quarters in male; three-quarters diameter apart. Posterior eyes two-thirds diameter apart in female. Posterior medians of male their radius apart, one diameter from laterals. Total length of female 1.4 mm. Carapace 0.64 mm. long, 0.59 mm. wide. First femur, 0.93 mm.; patella and tibia, 0.91 mm.; metatarsus, 0.65 mm.; tarsus, 0.39 mm. Second patella and tibia, 0.66 mm.; third, 0.49 mm.; fourth, 0.73 mm. Total length of male 1.7 mm. Carapace 0.88 mm. long, 0.75 mm. wide. Second patella and tibia, 1.16 mm.; third, 0.70 mm.; fourth, 0.97 mm.

It is possible that the male and female belong to different species. The female may be a *Theridion.*

Diagnosis. The genitalia (Figs. 29-31) distinguish this species.

Records. Trinidad: Simla, nr. Arima, ♀ paratypes (A. M. Nadler).

ACHAEARANEA ZONENSIS, new species
Figures 32-34

Type. Male holotype, from Experimental Gardens, Canal Zone, July 10-14, 1945 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Female: Carapace dusky yellow. Sternum yellow with sides dusky. Legs white with yellow-brown or dusky patellae and rings on ends of segments. Dorsum of abdomen black, or speckled gray and white. Venter anterior to pedicel with a white crossline; from middle of crossline two white streaks radiate anterior and to the sides. Black or gray between genital groove and spinnerets with a white spot on each side. Anterior median eyes one diameter apart, almost touching laterals. Posterior median eyes less than one diameter apart, two-thirds diameter from laterals. Abdomen without tubercle. Epigynum with a shallow depression and with a narrow sclerotized posterior lip. Openings side by side in depression, often in a darker area (Fig. 33). Total length 1.8-2.1 mm. Female holotype, total length 2.0 mm. Carapace, 0.69 mm. long, 0.57 mm. wide. First femur, 1.10 mm.; patella and tibia, 1.07 mm.; metatarsus, 0.80 mm.; tarsus, 0.45 mm. Second patella and tibia, 0.72 mm.; third, 0.52 mm.; fourth, 0.80 mm.

Male: Carapace white with a dusky median line, as wide as the posterior median eyes in front, narrower behind. Legs white, with indistinct light brown bands. Abdomen white behind and dusky in front, venter black, palpus (Fig. 34), small and of variable width. Total length 1.2 mm. Carapace 0.57 mm. long, 0.55 mm. wide. First femur, 1.04 mm.; patella and tibia, 0.97 mm.; metatarsus, 0.71 mm.; tarsus, 0.39 mm. Second patella and tibia, 0.73 mm.; third, 0.45 mm.; fourth, 0.66 mm.

Diagnosis. The pair of white ventral spots and the genitalia (Figs. 32-34) distinguish this species.

Records. Canal Zone: Experimental Gardens, Barro Colorado Island, ♀ allotype, paratypes (many records); Summit; France Field; Forest Reserve. *Panama:* Porto Bello; Arraiján.

ACHAEARANEA HIRTA (Taczanowski), new combination
Figures 35-38, Map 1

Argyrodes hirtus Taczanowski, 1872, Horae Soc. ent. Rossicae, vol. 9, p. 119. (♀ syntypes from Cayenne, French Guiana, in the Polish Academy of Sciences, Warsaw).

Achaea hirta, Keyserling, 1884, Die Spinnen Amerikas, vol. 2, no. 1, p. 104, pl. 5, fig. 67, ♀. Roewer, 1942, Katalog der Araneae, vol. 1, p. 445. Bonnet, 1955, Bibliographia Araneorum, vol. 2, p. 144.

Achaea undata Keyserling, 1884, *op. cit.,* vol. 2, no. 1, p. 105, pl. 5, fig. 68, ♀, ♂ (♀, ♂ syntypes from the province Amazonas, Brazil, in the Hope Department of Entomology, Oxford). NEW SYNONYMY.

Achaea guadalupensis Keyserling, 1884, *op. cit.,* vol. 2, no. 1, p. 110, pl. 5, fig. 72, ♀ (♀ type from Guadelupa, Peru, in the Polish Academy of Sciences, Warsaw). NEW SYNONYMY.

Achaea ignota Keyserling, 1884, *op. cit.,* vol. 2, no. 1, p. 112, pl. 5, fig. 73, ♀. (♀ type from Minas Geraes, Brazil, in the Hope Department of Entomology, Oxford). NEW SYNONYMY.

Theridion bentificum Keyserling, 1891, *op. cit.,* vol. 3, p. 184, pl. 6, fig. 129, ♂ (♂ type from Rio Grande do Sul, Brazil, in the British Museum, Natural History). Roewer, 1942, *op. cit.,* vol. 1, p. 490. NEW SYNONYMY.

Theridion ignotum, Simon, 1894, Histoire Naturelle des Araignées, vol. 1, p. 535, Roewer, 1942, *op. cit.,* vol. 1, p. 494. NEW SYNONYMY.

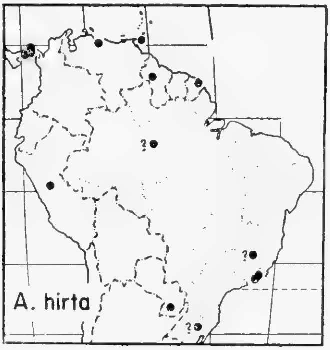
Theridion guadelupense, Simon, 1894, *op. cit.,* vol. 1, p. 535. NEW SYNONYMY.

Theridion undatum, Simon, 1894, *op. cit.,* vol. 1, p. 535. Roewer, 1942, *op. cit.,* vol. 1, p. 496. NEW SYNONYMY.

Chrysso maronica Caporiacco, 1954, Comm. Pontifica Acad. Scient., vol. 16, p. 74, fig. 11, ♀. (♀ type from S. Jean du Maroni, French Guiana, in the Museum National d'Histoire Naturelle, Paris). NEW SYNONYMY.

Description. Female: Carapace dark brown. Sternum reddish brown, in center yellowish white. Coxae yellow-white. Legs yellow-white with patellae, distal portions of femora, and tibiae red-brown. Abdomen (Fig. 38) marked with black, white and red-brown. Eyes subequal in size; posterior medians separated by their diameter, same distance from laterals. Height of clypeus equals about two diameters of anterior median eyes. Abdomen with a large tubercle. The epigynum is illustrated by Figure

36. Total length of females 1.9-2.9 mm. One female from Panama, total length, 2.6 mm. Carapace, 0.98 mm. long, 0.77 mm. wide. First femur, 1.82 mm.; patella and tibia, 1.80 mm.; metatarsus, 1.80 mm.; tarsus, 0.66 mm. Second patella and tibia, 1.17 mm.; third, 0.78 mm.; fourth, 1.24 mm.



Map 1. Distribution of *Achaearanea hirta* (Taczanowski).

Male: Abdomen higher than long, tubercle lacking. Palpus illustrated by Figure 37. Total length 1.6-2.0 mm. A male from Panama measured 1.8 mm. total length. Carapace, 1.00 mm. long, 0.78 mm. wide. First femur, 2.18 mm.; patella and tibia, 2.20 mm.; metatarsus, 2.10 mm.; tarsus, 0.65 mm. Second patella and tibia, 1.18 mm.; third, 0.75 mm.; fourth, 1.15 mm.

The types of Taczanowski and Keyserling were examined.

Variation. The ducts of the female genitalia are variable and may be at different angles. The epigynum may be opaque or transparent showing the ducts.

Records. Panama: El Valle; Arraiján; *Canal Zone:* Fort Randolph; Barro Colorado Island; Summit; Experimental Gardens; Fort Sherman; Pedro Miguel. *Trinidad:* Gasparee; Balandra Bay. *Venezuela:* Maracay. *British Guiana:* Kartabo, Bartica District. *Peru:* Tingo María, 670 m. *Brazil:* Rio Grande do Norte: Ceará Mirim. Minas Geraes: Minas de Serrinha Diamantina. Est. Rio de Janeiro; Cidade Rio de Janeiro; Teresópolis. *Paraguay:* Taguararapa, Alto-Panama.

ACHAEARANEA TAENIATA (Keyserling), new combination
Figures 39-41

Theridion taeniatum Keyserling, 1884, Die Spinnen Amerikas, vol. 2, pt. 1, p. 12, pl. 1, fig. 2, ♀, ♂. (♀, ♂ syntypes from Caracas, Venezuela, in the Institut Royal des Sciences Naturelles, Brussels.) Roewer, 1942, Katalog der Araneae, vol. 1, p. 499. Not *Steatoda taeniata*, F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 382, pl. 36, figs. 3, 4, ♀.

Description. Female: Carapace dusky brown. Sternum reddish brown. Legs yellow with patellae and distal ends of segments reddish. Abdomen nearly black with typical pattern of patches and lines; venter with area between spinnerets and genital furrow black with a white spot on each side. Carapace long with a thoracic depression. Anterior median eyes two-thirds diameter apart, one-quarter from laterals. Posterior eyes less than one diameter apart. Abdomen without tubercle. Epigynum (Fig. 40) two dark spots with an opening in the center; spots may be closer to margin or so large as to almost touch. Total length 3.2-5.2 mm. Total length of a female 4.5 mm. Carapace, 1.70 mm. long; 1.42 mm. wide. First femur, 2.65 mm.; patella and tibia, 2.89 mm.; metatarsus, 2.46 mm.; tarsus, 0.94 mm. Second patella and tibia, 1.75 mm.; third, 1.36 mm.; fourth, 2.10 mm.

Male: Lighter in coloration than female, dorsum of abdomen almost white. Palpus illustrated by Figure 41; conductor a transparent piece of variable shape on a stalk. Total length, 2.3-2.9 mm. Total length of a male, 2.4 mm. Carapace, 1.28 mm. long; 0.98 mm. wide. First femur, 2.34 mm.; patella and tibia, 2.41 mm.; metatarsus, 2.18 mm.; tarsus, 0.78 mm. Second patella and tibia, 1.53 mm.; third, 1.04 mm.; fourth, 1.33 mm.

Comments. Syntypes of this species have been examined.

Natural History. The eggsac is hung in a rolled up leaf.

Records. Guatemala: Quezaltenango (C. and M. Goodnight). *Costa Rica:* Escazú (Tristan). *Panama:* Boquete. *Canal Zone:* Barro Colorado Island (N. Banks; A. M. Chickering); Summit; Forest Reserve. *Lesser Antilles:* Trinidad: Port of Spain (R. Thaxter).

ACHAEARANEA PURA (O. P. Cambridge), new combination
Figures 42-44

Theridion purum O. P. Cambridge, 1894, Biologia Centrali Americana, Araneidea, vol. 1, p. 131, pl. 17, fig. 6, ♀. (♀ type from Omilteme, in the British Museum, Natural History.) Roewer, 1942, Katalog der Araneae, vol. 1, p. 497.

Steatoda pura, F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 383, pl. 36, fig. 10, ♀.

Natural History. "Found in a hollow at the root of a tree in a shady ravine, in a small den like an inverted cone, formed of bits of dried leaves etc." (O. P. Cambridge, 1894).

Records. Hidalgo: 10-20 mi. S. of Jacala. *Guerrero:* Omiltemi, 8000 ft., ♀ holotype. *Veracruz:* 10 mi. W.; 15 mi. west of Jalapa, ♀, ♂. *Morelos:* Cuernavaca, Sept. 1941, 1700 m. (H. Wagner), ♀.

ACHAEARANEA MARICAOENSIS (Bryant), new combination
Figures 45-50

Theridion maricaoensis Bryant, 1942, Jour. Agr. Univ. Puerto Rico, vol. 26, p. 2, figs. 2-4, ♂. (♂ type from Maricao Forest, 2500 ft., Puerto Rico, in the Museum of Comparative Zoology.)

Description. Female: Carapace black; sternum red-brown. Legs darker on distal ends. Abdomen with a black patch on each side, reddish brown and white (Fig. 45), venter gray with two small white spots side by side. Anterior median eyes one diameter apart, one-quarter from laterals. Posterior median eyes one diameter apart, two-thirds from laterals. Epigynum (Fig. 48) a depression with a posterior lip, often sufficiently transparent to show the diagnostic ducts (Fig. 46). Total length 2.2-3.6 mm. Measurements of a female from Panama: Total length, 2.5 mm. Carapace 1.17 mm. long, 0.85 mm. wide. First femur, 1.72 mm.; patella and tibia, 1.62 mm.; metatarsus, 1.30 mm.; tarsus, 0.65 mm. Second patella and tibia, 1.04 mm.; third, 0.78 mm.; fourth, 1.23 mm.

Male: Lighter in color than female. Bryant (1942) reports that the types have the anterior median eyes larger than the others. Palpus illustrated by Figures 49 and 50. Conductor of Central American specimens of same shape as that of type, but turned over; a recently molted specimen has conductor not quite folded over; total length 1.4-1.7 mm. Measurements of a male from Panama: total length: 1.7 mm. Carapace, 0.75 mm. long; 0.62 mm. wide. First femur, 1.10 mm.; patella and tibia, 1.26 mm.; metatarsus, 0.94 mm.; tarsus, 0.47 mm. Second patella and tibia, 0.81 mm.; third, 0.60 mm.; fourth, 0.81 mm.

Records. Panama: Boquete; Porto Bello. *Canal Zone:* Barro Colorado Island (N. Banks; A. M. Chickering); Madden Dam.

ACHAEARANEA TEREX, new species

Figure 52

Type. Male holotype from Banes, Oriente, Cuba, Aug. 1-3, 1955 (A. F. Archer), in the American Museum of Natural History.

Description. Carapace, sternum, femora yellow-white; other leg segments dusky. Abdomen white with a black spot on venter. Anterior median eyes almost twice the size of others, their diameter apart, almost touching laterals. Posterior medians one and one-third diameters apart, two-thirds diameters from laterals. Total length 1.3 mm. Carapace 0.60 mm. long, 0.52 mm. wide. First femur, 0.59 mm.; patella and tibia, 0.65 mm.; metatarsus, 0.47 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.50 mm.; third, 0.35 mm.; fourth, 0.52 mm.

Diagnosis. The black ventral abdominal spot, the short legs and the structure of the palpus (Fig. 52) differentiate this species from *A. mesax.*

Record. Panama Canal Zone: Barro Colorado Island, 1-7 July 1950; Experimental Gardens, 26 July 1954 (both A. M. Chickering).

ACHAEARANEA MESAX, new species

Figures 53-56

Steatoda taeniata, F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 382, pl. 36, figs. 3, 4, ♀, ♂ (err. det.).

Theridion alacre, Banks, 1929, Bull. Mus. Comp. Zool., vol. 69, p. 84 (err. det.).

Types. Male holotype, female allotype and one female paratype from Barro Colorado Island, Canal Zone, July 6, 1954 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Female: Carapace yellow with a dusky median line and dusky border. Sternum yellow. Legs golden yellow, ends of segments darker or dusky. Abdomen gray with characteristic white lines and dark spots (Fig. 53). Venter gray with some lighter spots. Eyes subequal in size, posterior median eyes separated by two-thirds their diameter, by three-quarters of width from laterals. Height of clypeus equals about two diameters of the anterior median eyes. Abdomen without a tubercle. Two spiracles near spinnerets, one-third distance between these and genital furrow. Epigynum has two large openings (Fig. 55) which lead into thin walled sacs of the internal genitalia (Fig. 54). Distance between openings and their shape variable. Area between openings and genital furrow often swollen, thus openings may face anterior. Total length of females 3.1-5.0 mm. One female total length: 3.5 mm. Carapace 1.49 mm. long, 1.29 mm. wide. First femur, 3.50 mm.; patella and tibia, 3.20 mm.; metatarsus, 2.9 mm.; tarsus, 0.87 mm. Second patella and tibia, 1.94 mm.; third, 1.23 mm.; fourth, 2.14 mm.

Male: Anterior median eyes two-thirds diameter apart, one-quarter diameter from laterals, posterior eyes one diameter apart. Palpus illustrated by Figure 56. Total length 1.4-1.6 mm. Male holotype total length 1.6 mm. Carapace, 0.78 mm. long; 0.70 mm. wide. First femur, 1.33 mm.; patella and tibia, 1.36 mm.; metatarsus, 1.20 mm.; tarsus, 0.50 mm. Second patella and tibia, 0.92 mm.; third, 0.62 mm.; fourth, 0.81 mm.

Diagnosis. Only the wider and longer embolus of the palpus (Fig. 56) separate this species from *A. obnubilum* Keyserling, found in Brazil.

Specimens determined by F. P. Cambridge as *Steatoda taeniata* Keyserling were examined.

Records. Veracruz: 10 mi. S. of San José del Carmen, April 16, 1953 (L. I. Davis). *Tabasco:* Teapa (F. P. Cambridge, 1902). *Panama:* Boquerón River; Gamboa. *Canal Zone:* Barro Colorado Island; Summit; Fort Randolph; Experimental Gardens; Fort Sherman. *Cuba:* Soledad, Vilcher's Hill, Aug. 1931 (L. A. Worley), ♀.

ACHAEARANEA MACHAERA, new species
Figure 51

Type. Male type from El Volcán, Panama, March 7, 1936 (W. J. Gertsch), in the American Museum of Natural History.

Description. Carapace, sternum orange. Legs light yellow. Abdomen red except for black cap on dorsum and a large black spot on venter. Anterior median eyes slightly larger than others, their diameter apart, less than a quarter from laterals. Posterior eyes their diameter apart. Total length of male 1.3 mm. Carapace, 0.65 mm. long, 0.65 mm. wide. Second patella and tibia, 0.81 mm.; third, 0.55 mm.; fourth, 0.80 mm.

Diagnosis. The conductor of the palpus which is enormously enlarged (Fig. 51) distinguishes this species.

ACHAEARANEA TRAPEZOIDALIS (Taczanowski)

Achaearanea trapezoidalis, Levi, 1955, Amer. Mus. Novitates, no. 1718, p. 9, figs. 7-18, ♀, ♂.

Distribution. South America, north to Panama.

Records. Panama: Arraiján. *Canal Zone:* Experimental Gardens; Forest Reserve; Summit; Chilibre; Barro Colorado Island. *Lesser Antilles:* Trinidad: Balandra Bay.

ACHAEARANEA TESSELATA (Keyserling), new combination

Figures 70-71

Theridion tesselatum Keyserling, 1884, Die Spinnen Amerikas, vol. 2, no. 1, p. 48, pl. 2, fig. 27, ♀ (♀ type from Nancho, Peru, in the Warsaw, Poland, Museum). Kraus, 1955, Abhandl. Senckenbergischen Naturf. Gesell., no. 493, pl. 16, pl. 2, fig. 30, ♀.

Figures were made from specimens in the Paris Museum determined by Keyserling.

Distribution. Peru; Venezuela; Rio de Janeiro, Brazil (Keyserling, 1883); El Salvador (Kraus, 1955).

ACHAEARANEA PICADOI (Banks), new combination

Figures 57-60

Theridion picadoi Banks, 1909, Proc. Acad. Nat. Sci. Philadelphia, p. 204. (♀ type from Orosi, Costa Rica, in the Museum of Comparative Zoology.)

Steatoda americana, Banks, 1909, *ibid.*, p. 205 (err. det.).

Theridion alacre, Banks, 1929, Bull. Mus. Comp. Zool., vol. 69, p. 84 (err. det.).

Description. Female: Carapace yellow-brown, dusky on sides. Sternum, legs brown. Abdomen dorsum with a lanceolate brown spot enclosed by a white line from which go two to three white lines down each side. Rich brown in between lines. Venter brown between genital groove and spinnerets, lighter on each side. Some females have abdomen almost gray. Anterior median eyes one diameter apart, less than one-quarter from laterals. Posterior median eyes one and one-quarter diameters apart, two-thirds from laterals. Epigynum (Figs. 58, 60) a deep oval depression with a narrow translucent lateral and posterior rim. Connecting ducts (Figs. 57, 59) dark and unlike those of *A. tesselata*. Total length of females 4.0-4.5 mm. Total length of type, 4.3 mm. Carapace, 1.4 mm. long, 1.3 mm. wide. First femur, 2.2 mm.; patella and tibia, 2.0 mm.; metatarsus, 2.0 mm.; tarsus, 0.7 mm. Second patella and tibia, 1.5 mm.; third, 1.2 mm.; fourth, 1.9 mm.

Variation. The connecting ducts of northern specimens are slightly diverging as they approach the seminal receptacles. It is possible that *A. tesselata* is a race of this species.

Distribution. A picadoi may be cosmotropical. Among some theridiids loaned to me from Merauke, New Guinea, by Fr. Chrysanthus was a specimen believed to be this species. Since the males are unknown and the females can only be recognized by examining internal genitalia, which unfortunately has not been done by many arachnologists, it is not known if it has been described from other areas.

Records. Tamaulipas: Villa Juárez (L. I. Davis). *San Luis Potosí:* Tamazunchale (L. I. Davis). *Distrito Federal:* (H. Wagner). *El Salvador:* (Kraus, 1955); San Salvador (J. B. Boursot). *Costa Rica:* Escazú; Anonos (Tristan). *Canal Zone:* Barro Colorado Isl. (sev. coll.). *Trinidad:* St. Augustine.

ACHAEARANEA MANZANILLO, new species
Figures 27-28

Types. Female holotype from Miramar, Manzanillo, Colima, Mexico, January 15, 1943 (F. Bonet), in the American Museum of Natural History.

Description. Female: Coloration similar to that of *A. rupicola* (Emerton), except for first legs, the femora and patellae of which are white, with only distal ends of tibiae and metatarsi striped. Eyes subequal in size; posterior medians separated by one-half their diameter, by one-third from laterals. Height of clypeus equals one diameter of anterior median eyes. Abdomen with a large posterior tubercle. Total length, 1.8 mm. Carapace, 0.74 mm. long, 0.65 mm. wide. First femur, 1.04 mm.; patella and tibia, 0.97 mm.; metatarsus, 0.68 mm.; tarsus, 0.44 mm. Second patella and tibia, 0.65 mm.; third, 0.52 mm.; fourth, 0.78 mm.

Diagnosis. This species can be distinguished from others of the *A. rupicola* group by the widely separated dark spots and the median lobe of the anterior margin of the epigynum (Fig. 28), as well as by the internal genitalia (Fig. 27).

ACHAEARANEA OBLIVIA (O. P. Cambridge), new combination

Figures 61-63

Theridion oblivium O. P. Cambridge, 1896, Biologia Centrali Americana, Araneidea, vol. 1, p. 207, pl. 24, fig. 13, ♀. (♀ type from Costa Rica in the British Museum, Natural History.) Roewer, 1942, Katalog der Araneae, vol. 1, p. 496.

Steatoda obliva, F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 383, pl. 36, fig. 9, ♀.

Description. Female: Carapace dusky yellow-brown. Sternum dusky brown. Legs yellowish-white, patellae and middle and distal ends of segments with dusky brown rings; brown rings as long as light ones. Abdomen black with lighter patches; a white band from tubercle to spinnerets, narrow near tubercle, wider near spinnerets. Anterior median eyes one diameter apart, three-quarters from laterals. Posterior eyes one diameter apart. Clypeus projecting below eyes. Abdomen with a tubercle. Epigynum (Figs. 62, 63) a projecting lobe with two dark spots on the tip. Measurements: total length 5.2 mm. Carapace 2.2 mm. long, 1.8 mm. wide. First femur, 3.7 mm.; patella and tibia, 4.2 mm.; metatarsus, 4.0 mm.; tarsus, 1.4 mm. Second patella and tibia, 2.7 mm.; third, 2.0 mm.; fourth, 3.2 mm.

Comments. This species may belong to the genus *Tidarren;* the male is not known. Specimens determined by F. P. Cambridge were examined.

Records. Costa Rica: La Verbena (Tristan). *Panama:* El Volcán, August 4-9, 1950 (A. M. Chickering). Cerro Punta, Chir., March 4, 1936 (W. J. Gertsch).

ACHAEARANEA ROSTRATA (O. P. Cambridge), new combination
Figures 64-66

Theridion rostratum O. P. Cambridge, 1896, Biologia Centrali Americana, Araneidea, vol. 1, p. 204, pl. 24, fig. 10, ♀. (♀ type from Teapa, Tabasco, in the British Museum, Natural History.) Roewer, 1942, Katalog der Araneae, vol. 1, p. 497.

Description. Female: Carapace, sternum, dusky brown. Legs, dusky brown with indistinct darker bands. Abdomen black with characteristic white streaks on dorsum. Anterior median eyes three-quarters diameter apart, one-quarter diameter from laterals. Posterior eyes three-quarters diameter apart. Abdomen without tubercle. Two spiracles one-third distance between spinnerets and genital groove. Epigynum (Figs. 65, 66) cone shaped with a white tip; on each side of tip is an opening. Duct of internal genitalia (Fig. 64) coiled. Total length, 2.3-3.2 mm. Measurements: total length, 2.5 mm. Carapace, 0.98 mm. long, 0.85 mm. wide. First femur, 1.33 mm.; patella and tibia, 1.30 mm.; metatarsus, 1.09 mm.; tarsus, 0.62 mm. Second patella and tibia, 0.93 mm.; third, 0.73 mm.; fourth, 1.17 mm.

Comments: Several specimens determined by Cambridge from the type locality were examined.

Record. Guatemala: Chicoyoito (Sargent). *Costa Rica:* Tejar de Cartago (Tristan).

THERIDION Walckenaer

Theridion Walckenaer, 1805, Tableau des aranéides, p. 72. Type species *Aranea picta* Walckenaer, designated by Opinion 517 of the Int. Comm. on Zool. Nomencl., May 30, 1958. Name placed on Official List of Generic Names in Zoology.

Wamba O. P. Cambridge, 1896, Biologia Centrali Americana, Araneidea, vol. 1, p. 190. Type species by monotypy *Wamba congener* O. P. Cambridge (= *Theridion atropunctatum* Petrunkevitch).

The species placed in this genus are all of medium size and have relatively long legs. Unlike many theridiid genera, *Theridion* lacks a colulus. The palpus is complex, a radix is always present; only rarely is this structure reduced or secondarily absent. The carapace and abdomen are not modified, although the abdomen may be wider than long.

The following species of this region, described in *Theridion*, do not belong to it, and also do not belong to the other genera revised in this paper.

cambridgei Petrunkevitch, 1911, belongs to *Chrysso*.

delebile Petrunkevitch, 1930 = *Coleosoma floridanum* Banks.

fordulum Banks, 1909 = *Tidarren fordum* (Keyserling).

jucundum O. P. Cambridge, 1896 = *Anelosimus jucundus*.

munifex O. P. Cambridge, 1896 = *Chrosiothes silvaticus* Simon [*Theridiotis probabilis* (O. P. Cambridge)]. NEW SYNONYMY.

santaanae Kraus, 1955, belongs to the family Nesticidae.

splendens Roewer, 1942, belongs to *Chrysso*.

The following species of *Theridion* has been inadequately described, without illustration, and the type has been lost: *fuesslyi* Simon, 1894, from St. Vincent Island.

THE THERIDION MURARIUM GROUP

Species of this group found in this region and also occurring north of Mexico, illustrated in a previous paper (1957, Bull. Amer. Mus. Nat. Hist., vol. 112), are:

THERIDION MURARIUM Emerton

Theridion murarium, Levi, 1957, p. 22, figs. 12, 57, 58, 61-63, ♀, ♂; map 5.

Distribution. Southern Canada, south to Chiapas.

THERIDION RABUNI Chamberlin and Ivie

Theridion rabuni, Levi, 1957, p. 28, figs. 81-86, ♀, ♂, map 7.

Distribution. United States and Bahama Isl.

Additional record. *Bahama Isl.:* Crooked Isl. (E. B. Hayden).

THERIDION CINCTIPES Banks

Theridion cinctipes, Levi, 1957, p. 29, figs. 87, 88, 99, ♂; map 11.

Distribution. Texas and Jalisco.

THERIDION MYERSI Levi

Theridion myersi Levi, 1957, p. 31, figs. 95-98, ♀, ♂; map 12.

Distribution. Florida, Tamaulipas to Oaxaca, Jamaica.

Additional Records. Jamaica: Palisades, Kingston (A. M. Chickering); Mona, St. Andrew Par. (A. M. Chickering); Agric. School, St. Catherine Par. (A. M. Chickering).

THERIDION FLAVONOTATUM Becker

Theridion flavonotatum, Levi, 1957, p. 34, figs. 102, 103, 107, 109, ♀, ♂; map 9.

Distribution. Southeastern United States, Cuba.

Additional record. Cuba: Soledad, Vilche's Hill, Oriente (L. G. Worley).

THERIDION DILUTUM Levi

Theridion dilutum Levi, 1957, p. 37, figs. 112, 123-125, ♀, ♂; map 10.

Distribution. Southwestern United States to Oaxaca.

Additional records. Nuevo Léon: Villagrán (V. Roth and W. J. Gertsch). *Chihuahua:* 25 mi. W. of Camargo (W. J. Gertsch). *San Luis Potosí:* Valles (W. J. Gertsch and V. Roth). *Nayarit:* 20 mi. N. of Tepic (W. J. Gertsch and V. Roth). *Jalisco:* W. side of Lago de Sayula (W. J. Gertsch and V. Roth). *Guanajuato:* San Miguel Allende (C. and P. Vaurie). *Hidalgo:* Alfajayucan, Ixmiquilpan (H. Wagner); Tepeji (A. M. and L. I. Davis). *Oaxaca:* Huajuapan (H. Wagner).

THERIDION CYNICUM Gertsch and Mulaik

Theridion cynicum, Levi, 1957, p. 39, figs. 126-128, ♀, ♂; map 11.

Distribution. Texas to Guerrero.

Additional records. Tamaulipas: Río Guajolotes, 40 mi. S. of Victoria, ♂. *Hidalgo:* Jacala, ♀. *Veracruz:* Plan del Río, ♂. *Guerrero:* 11 mi. W. of Chilpancingo, ♀ (all W. J. Gertsch and V. Roth).

THERIDION CAMERONENSE Levi

Figures 74, 75

Theridion cameronense Levi, 1957, p. 40, figs. 114, 115, ♀; map 14.

Comments. The loop of the connecting ducts is longer in southern specimens. In a specimen from Guerrero it reached the anterior end of the seminal receptacles.

Distribution. Southern Texas to southern Mexico.

Additional Records. Tamaulipas: Ciudad Victoria (A. M. and L. I. Davis). *Nuevo Léon:* Villagrán (V. Roth; W. J. Gertsch). *Guerrero:* Taxco (L. Isaacs). *Chiapas:* Río de las Flores, 30 km. NE. of Cintalapa (H. Wagner).

THERIDION AUSTRALE Banks

Theridion australe, Levi, 1957, p. 41, figs. 131, 132, 148-151, map 12.

Comments. A male and a female from the West Indies differ in lacking the black cap over the eyes, and the male has a median apophysis lacking the ventral lobe which extends toward the proximal end of the palpus; thus it appears to look more like the median apophysis of *T. hidalgo* or *T. geminipunctum* (which are not found in the West Indies and have a different embolus). There is some indication that *T. goodnightorum* is a subspecies of *T. australe.*

A male specimen had been labeled paratype of *Theridion maricaoense* Bryant.

Distribution. Utah, southeastern United States, Puerto Rico, West Indies.

Records. Bahama Isl.: Cockburn Town, San Salvador Isl., ♂ (Rabb, L. Giovannoli). *Haiti:* hill nr. Port au Prince, 2000 ft. (P. J. Darlington). *Puerto Rico:* Maricao Forest, 2500 ft., ♂ (P. J. Darlington).

THERIDION GOODNIGHTORUM Levi

Theridion goodnightorum Levi, 1957, p. 41, figs. 129, 130, 145-147, ♀, ♂; map 12.

Comments. Most specimens from Mexico have a dusky venter. The species differs from *T. australe* in being larger in size and having different coloration; the genitalia are very similar. However, since West Indian *T. australe* lack the typical coloration of that species, and since Mexican specimens of *T. goodnightorum* seem smaller, it is very possible that *T. goodnightorum* will have to be considered a subspecies of *T. australe.*

Distribution. Wyoming to California south to southern Mexico.

Additional records. Nayarit: Jalisco (Blanche). *Hidalgo:* 10-25 mi. S. of Jacala (V. Roth and W. J. Gertsch). *Distrito*

Federal: Xochimilco (H. Wagner). *Puebla:* Tehuacán (V. Roth and W. J. Gertsch). *Chiapas:* Pichucalco (C. and M. Goodnight).

THERIDION HIDALGO Levi

Theridion hidalgo Levi, 1957, p. 43, figs. 133, 134, 139-141, ♀, ♂; map 13.

Distribution. Central Texas to Tamaulipas.

Additional record. Tamaulipas: Padilla (W. J. Gertsch).

THERIDION GEMINIPUNCTUM Chamberlin

Theridion geminipunctum, Levi, 1957, 135-136, 142-144, ♀, ♂; map 13.

Distribution. Southern California, Baja California.

THERIDION TRANSGRESSUM Petrunkevitch

Theridion rotundum O. P. Cambridge, 1898, Biologia Centrali Americana, Araneidea, vol. 1, p. 254, pl. 34, fig. 7, ♀ (♀ types from Pátzcuaro, Michoacan, in the British Museum, Natural History). Name preoccupied by *Theridion rotundum* Keyserling, 1891. NEW SYNONYMY.

Theridion transversum O. P. Cambridge, 1898, *ibid.*, p. 256, pl. 35, figs. 3, 4, ♀, ♂ (♀, ♂ types from Mexico City, in the British Museum, Natural History). Name preoccupied by *Theridion transversum* Nicolet, 1849.

Steatoda compressa F. P. Cambridge, 1902, *op. cit.*, vol. 2, p. 383, pl. 36, fig. 12, ♀. New name for *Theridion rotundum*. Not *Achaea compressa* Keyserling, 1884. NEW SYNONYMY.

Theridion rotundatum Petrunkevitch, 1911, Bull. Amer. Mus. Nat. Hist., vol. 29, p. 204. New name for *Theridion rotundum*. NEW SYNONYMY.

Theridion transgressum Petrunkevitch, 1911, *op. cit.*, p. 208. New name for *Theridion transversum*. Levi, 1957, p. 47, figs. 154, 157, 158, ♀, ♂; map 14.

Comment. Since some arachnologists might still consider *Achaea compressa* Keyserling to belong to *Theridion*, stability of nomenclature would be served by keeping the name *Theridion transgressum*.

Distribution. Utah to Central Mexico.

Additional Records. Durango: 10 mi. E. of El Salto (W. J. Gertsch). *Hidalgo:* 6 mi. N. of Jacala (C. and P. Vaurie). *Morelos:* Zempoala N. P., 2800 m. (B. Malkin).

THERIDION KAWEA Levi

Theridion kawea Levi, 1957, p. 48, figs. 118, 119, ♀; map 6.

Distribution. Utah, California to Chihuahua.

THERIDION SUBMISSUM Gertsch and Davis
Figures 89-90

Theridion submissum, Levi, 1957, p. 38, figs. 116, 117, ♂, map 11.

Description. Female: Coloration yellow-white, except abdomen which is white. Anterior median eyes one diameter apart almost touching laterals. Posterior eyes their diameter apart. Total length 2.3 mm. Carapace 0.91 mm. long, 0.78 mm. wide. First femur, 1.43 mm.; patella and tibia, 1.52 mm.; metatarsus, 1.17 mm.; tarsus, 0.52 mm. Second patella and tibia, 0.77 mm.; third, 0.52 mm.; fourth, 0.89 mm.

The epigynum has an indistinct depression close to the posterior border, and is somewhat swollen in the middle (Fig. 90).

Distribution. Southwestern United States to Chiapas, Jamaica, Bahamas.

Additional Records. Jalisco: nr. Tequila, ♂ (V. Roth and W. J. Gertsch). *Oaxaca:* San Felipe, ♂ (H. Wagner). *Chiapas:* Cintalapa, ♂ (H. Wagner). *Bahama Isl.:* Rum Cay nr. Port Nelson, ♀ (Hayden and Giovannoli). *Jamaica:* 3 mi. N. of Spanish Town, St. Catharine Par., ♀ (A. M. Nadler); Mona pasture, St. Andrew Par., ♀, ♂ (A. M. Chickering); Kingston, ♀; Liguanea, St. Andrew Par., ♀ (A. M. Chickering).

THERIDION DILUCIDUM Simon
Figures 78-81; Map 2

Theridion dilucidum Simon, 1897, Proc. Zool. Soc. London, p. 862 (♀ types from St. Vincent Island, Lesser Antilles, in the British Museum, Natural History).

Theridion defunctum Petrunkevitch, 1925, Trans. Connecticut Acad. Sci., vol. 27, p. 103, figs. 13, 14, ♂ (♂ type from Wilcox Camp at San Lorenzo River, Panama, probably lost). NEW SYNONYMY.

Theridion atkinsi Bryant, 1940, Bull. Mus. Comp. Zool., vol. 86, p. 317, figs. 72, 73, 77, ♀, ♂ (♂ type from Soledad, Cuba, in the Museum of Comparative Zoology). NEW SYNONYMY.

Theridion virginus Bryant, 1942, *ibid.*, vol. 89, p. 344, fig. 27, ♂ (♂ type from St. Croix, Virgin Islands, in the Museum of Comparative Zoology).

NEW SYNONYMY.

Comments. Type specimens of *T. dilucidum* were examined. The epigynum (Fig. 79) has an anterior curved sclerotized plate, and a posterior depresison; in between is a projecting carina. This species is close to *T. myersi* Levi, but can be separated by the internal female genitalia.

Map 2. Distribution of *Theridion coyoacan*, new species, and *T. dilucidum* Simon.

Records. Costa Rica. Canal Zone: Barro Colorado Isl., common (A. M. Chickering, A. M. Nadler); Experimental Gardens; 3 mi. N. of Pedro Miguel; Ft. Clayton; nr. Cocoli; Madden Dam; Gamboa; Forest Reserve; Pedro Miguel; Gatun; Diablo; Corozal; Summit, common (all A. M. Chickering). *Cuba:* (Bryant, 1940). *Jamaica:* Very common at low elevations. *Dominican Republic:* Puerto Plata (D. Hurst); Valle de Polo, 2-3000 ft. (H. B. Hassler). *Isla Desecheo. Puerto Rico:* Port Grillo, San Germán (A. M. Nadler). *Virgin Islands:* (Bryant, 1942). *St. Vincent Isl.:* (Simon, 1894).

THERIDION GALERUM, new species

Figures 82-86

Type. Male type from Experimental Gardens, Canal Zone, Aug. 12-19, 1954 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace dusky olive to black, eyes reddish. Sternum dusky olive. Legs dusky yellow-white with black spots, distal segments darker. Abdomen black, dorsum with a median band which is white at the narrower ends, reddish in the middle and having a narrow white border; venter with a white spot posterior to genital furrow. Anterior median eyes one diameter apart, almost touching laterals. Posterior medians three-quarters diameter apart, one diameter from laterals. Total length of females 1.6-2.3 mm. A female measured total length 2.0 mm. Carapace 0.78 mm. long, 0.67 mm. wide. First femur, 0.91 mm.; patella and tibia, 0.99 mm.; metatarsus, 0.66 mm.; tarsus, 0.40 mm. Second patella and tibia, 0.75 mm.; third, 0.52 mm.; fourth, 0.78 mm. A male measured total length 1.4 mm. Carapace 0.75 mm. long, 0.66 mm. wide. First femur, 1.04 mm.; patella and tibia, 1.12 mm.; metatarsus, 0.78 mm.; tarsus, 0.39 mm.; Second patella and tibia, 0.81 mm.; third, 0.52 mm.; fourth, 0.75 mm.

Diagnosis. The genitalia (Figs. 82-86) distinguish this from other small dark *Theridion.* The epigynum (Fig. 83) is a depression on a coneshaped raised area. Often the depression is filled with a plug which is drawn out to a point (Fig. 84) but is variable in shape.

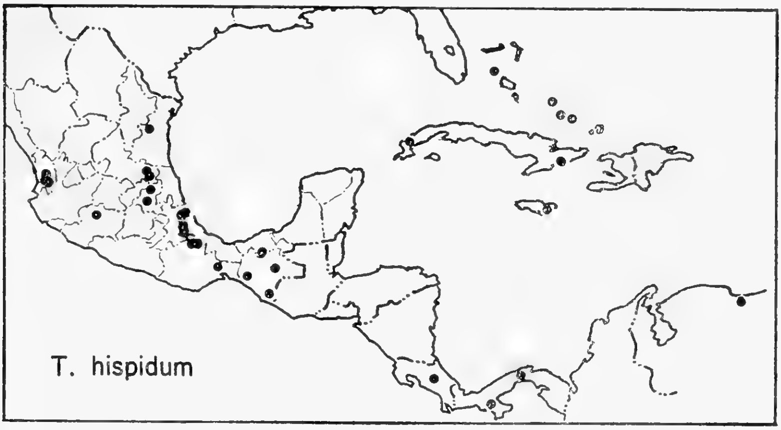
Records. Canal Zone: Experimental Gardens; Barro Colorado Isl.; (several coll.); Madden Dam, (all A. M. Chickering); Summit (A. M. Chickering; A. M. Nadler).

THERIDION HISPIDUM O. P. Cambridge
Figures 95-102; Map 3

Theridion hispidum O. P. Cambridge, 1898, Biologia Centrali Americana, Araneidea, vol. 1, p. 253, pl. 35, fig. 5, ♂ (♂ type from Teapa in Tabasco, Mexico, in the British Museum of Natural History).

Theridion hirsutum O. P. Cambridge, 1898, *op. cit.*, pl. 34, fig. 6, ♂. Nomen nudum.

Description. Carapace, sternum, legs yellow-white. Abdomen white, dorsum covered by pigment spots; sometimes dark in color. Anterior median eyes more than their diameter apart, one-third from laterals. Posterior eyes about a third their diameter apart. Epigynal depression (Figs. 96, 98, 100) sometimes with a septum. Total length of females, 1.9-3.0 mm. A female from Panama measured 2.5 mm. total length. Carapace 0.95 mm. long, 0.80 mm. wide. First femur, 1.82 mm.; patella and tibia, 1.57 mm.; metatarsus, 1.43 mm.; tarsus, 0.52 mm. Second patella and tibia, 1.10 mm.; third, 0.70 mm.; fourth, 1.05 mm. Total length of males 1.6-2.2 mm. A male from Panama measured 1.6 mm. total length. Carapace 0.91 mm. long, 0.81 mm. wide. First femur, 1.82 mm.; patella and tibia, 1.91 mm.; metatarsus, 1.51 mm.; tarsus, 0.55 mm. Second patella and tibia, 1.24 mm.; third, 0.65 mm.; fourth, 0.98 mm.



Map 3. Distribution of *Theridion hispidum* O. P. Cambridge.

Variation. In several specimens from Veracruz the openings of the epigynum are much smaller (Fig. 98); it is not known if these females belong to this species or not. There is some variation in the internal genitalia of females.

Records. Tamaulipas: 40 mi. S. of Linares (A. M., L. I., C. Davis). *San Luis Potosí:* Huichihuayán (W. J. Gertsch); Valles (W. J. Gertsch; V. Roth). *Nayarit:* Tepic (B. Malkin); Compostela (W. J. Gertsch); 20 mi. S. of Tepic (W. J. Gertsch; V. Roth). *Veracruz:* Córdoba (J. C. and D. L. Pallister); Tlalpacoyan (H. Wagner); Mantla (H. Wagner); Martínez de la Torre (H. Wagner); Fortín (W. J. Gertsch; V. Roth). *Hidalgo:* Chapulhuacán (W. J. Gertsch); Ixmiquilpan (H.

Wagner). *Michoacan:* nr. Cherán (F. H. Pough). *Oaxaca:* Playa Hati, Río Tonto (H. Wagner); Papaloápan (H. Wagner); Palomares. *Chiapas:* Ocosingo, 900 m. (C. and M. Goodnight; L. J. Stannard); Tonalá; nr. Cacahoatán (C. and M. Goodnight); Río de las Flores (H. Wagner). *Costa Rica:* San José (E. Schmidt). *Panama:* Boquete; Porto Bello (both A. M. Chickering). *Canal Zone:* Barro Colorado Isl. (many records); Experimental Gardens; Summit; (all A. M. Chickering). *Jamaica:* Stony Hill, St. Andrew Par. (A. M. Chickering). *Bahama Islands:* Cat Isl. (E. B. Hayden); Gt. Inagua Isl. (E. B. Hayden); Berry Isl. (E. B. Hayden); Crooked Isl. (G. Rabb); Long Isl. (E. B. Hayden). *Cuba:* San José (L. G. Worley); Soledad (L. G. Worley); Sierra de Anafe, Piñar del Río (M. Barro). *Venezuela:* Maracay (A. M. Nadler).

THERIDION VALLECULUM, new species
Figures 103-104

Type. Male type from El Valle, Panama, July 1936 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Yellow-white except for some white pigment on dorsum of abdomen. Anterior median eyes their diameter apart, almost their diameter from laterals. Posterior median eyes one-third diameter apart, two-thirds from laterals. Total length 1.4 mm. Carapace 0.78 mm. long, 0.62 mm. wide. Third patella and tibia, 0.50 mm.; fourth, 0.73 mm.

Diagnosis. Details of the median apophysis (Fig. 103) and the curvature of the embolus (Fig. 104) separate this species from *T. intritum*.

THERIDION BRYANTAE Roewer
Figures 76, 77

Theridion placidum Bryant, 1948, Psyche, vol. 55, p. 58, fig. 5, ♀. (♀ type from Acapulco, Guerrero, in the Museum of Comparative Zoology). Name preoccupied by *T. placidum* Roewer, 1942.

Theridion bryantae Roewer, 1951, Abhandl. Naturwiss. Ver. Bremen, vol. 32, p. 455. New name for *T. placidum* Bryant preoccupied.

THERIDION ELISABETHAE Roewer

Figures 87, 88

Theridion maculipes Bryant, 1948, Psyche, vol. 55, p. 57, fig. 3, ♀. (♀ type from Acapulco, Guerrero, in the Museum of Comparative Zoology). Name preoccupied by *T. maculipes* Urquhart, 1886.

Theridion elisabethae Roewer, 1951, Abhandl. Naturwiss. Ver. Bremen, vol. 32, p. 455. New name for *T. maculipes* Bryant preoccupied.

Records. Sinaloa: Mazatlán (F. H. Pough). *Panama:* Playa Grande (A. M. Nadler).

THERIDION GERTSCHI, new species

Figures 91, 92

Type. Female type from Madera, Chihuahua, July 5, 1947 (W. J. Gertsch), in the American Museum of Natural History.

Description. Carapace, sternum dusky orange. Legs yellow-white with orange bands. Dorsum of abdomen with a medium white stripe the sides of which are black; sides of dorsum light gray. Sides of abdomen white. Venter dark with a large white spot between genital groove and spinnerets. Anterior median eyes slightly larger than others, their diameter apart, one-quarter from laterals. Posterior median eyes oval, their longest radius apart, their largest diameter from laterals. Total length of female 3.0 mm. Carapace 1.35 mm. long; 1.17 mm. wide. First femur 2.14 mm.; patella and tibia, 2.26 mm.; metatarsus, 1.85 mm.; tarsus, 0.72 mm. Second patella and tibia, 1.55 mm.; third, 0.96 mm.; fourth, 1.54 mm.

Diagnosis. The epigynum which is a relatively flat shield has the rim curled at the anterior (Fig. 92) and differentiates this species from others of the *T. murarium* group.

Records. Arizona: Madera Canyon, Santa Rita Mts. (W. J. Gertsch). *Chihuahua:* Madera (W. J. Gertsch).

THERIDION DAVISORUM, new species

Figures 72, 73

Type. Female type from 25 miles west of Monterrey, Nuevo León, July 6, 1936 (L. I. Davis), in the American Museum of Natural History.

Description. Carapace, sternum, legs yellow-white, legs with a few black lines crossing venter of segments. Abdomen white. Anterior median eyes slightly larger than others, three-quarters their diameter apart, almost touching laterals. Posterior median eyes two-thirds diameter apart, one diameter from laterals. Total length of female 2.9 mm. Carapace 1.04 mm. long, 0.91 mm. wide. First femur, 1.62 mm.; patella and tibia, 1.69 mm.; metatarsus, 1.30 mm.; tarsus, 0.59 mm. Second patella and tibia, 1.05 mm.; third, 1.00 mm.; fourth, 1.06 mm.

Diagnosis. This species differs from *T. cameronense* in that the openings of the epigynum (Fig. 73) are farther from the margin. The internal genitalia also differ.

THERIDION CENTRUM, new species
Figures 208, 209

Type. Female type from Chiriqui Province, Panama, 1938, in the American Museum of Natural History.

Description. Carapace yellow-white with a median dusky band, wide in front, narrow behind. Legs yellow-white with narrow dusky bands around ends of femora, middle and ends of tibiae and metatarsi. Abdomen yellow-white with median dorsal white patches forming a band and a series of black spots on the sides and a pair of black spots above spinnerets. Eyes subequal in size; anterior median eyes one and one-quarter diameters apart, one-third diameter from laterals. Posterior eyes one diameter apart. Chelicerae with two teeth on anterior margin. Total length 3.3 mm. Carapace 1.4 mm. long, 1.0 mm. wide. First femur 3.2 mm., patella and tibia 3.2 mm., metatarsus 3.0 mm., tarsus 0.9 mm. Second patella and tibia 1.7 mm., third 1.1 mm., fourth 1.9 mm.

Diagnosis. The epigynum having an opening near the posterior margin and the duct of the internal genitalia (Figs. 208, 209) separate this species from *Theridion arizonense.*

THERIDION ARCHERI, new species
Figures 93, 94

Type. Female type from Ceiba, Oriente, Cuba, from Camp of Babun Lumber Co., July 2, 3, 1955 (A. F. Archer), in the American Museum of Natural History.

Description. Carapace, sternum, legs yellow. Abdomen with white pigment and two rows of small dusky spots on dorsum. Anterior median eyes slightly larger than others, two-thirds diameter apart, less than one-fourth from laterals. Posterior eyes slightly less than one diameter apart. Total length of female 3.0 mm. Carapace 0.96 mm. long, 0.81 mm. wide. First femur 1.32 mm.; patella and tibia, 1.46 mm.; metatarsus, 1.14 mm.; tarsus, 0.55 mm. Second patella and tibia, 0.97 mm.; third, 0.77 mm.; fourth, 1.20 mm.

Diagnosis. The epigynum and the internal genitalia (Figs. 93, 94) separate this species from others of the *T. murarium* group.

Record. Cuba: Santiago, Oriente (P. Alayo).

THERIDION CAVIPALPE (F. P. Cambridge)
Figure 205

Steatoda cavipalpus F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 382, pl. 36, fig. 6, ♂ (♂ type from Guatemala, in the British Museum, Natural History).

Theridion cavipalpe, Roewer, 1942, Katalog der Araneae, vol. 1, p. 491.

The cymbium of the palpus is modified like in *Theridion michelbacheri.*

Record. Guatemala: Nebaj (C. and P. Vaurie).

THE THERIDION FRONDEUM GROUP

Species belonging to this group found in this region and also occurring north of Mexico, illustrated in a previous paper (1957, Bull. Amer. Mus. Nat. Hist., vol. 112) are:

THERIDION PUNCTIPES Emerton

Theridion punctipes, Levi, 1957, p. 75, figs. 261-266, ♀, ♂; map 34.

Distribution. Pacific coast states, Baja California.

THERIDION FRONDEUM Hentz

Theridion frondeum, Levi, 1957, p. 81, figs. 288-289, 298-299, ♀, ♂; map 27.

Comments. Although there are many literature records of *T. frondeum* from the West Indies, Mexico to South America, these are probably all misidentifications. However, one male of this species, whose range is the eastern United States north of Georgia, was found in Englishtown, Bahamas, July 14, 1937 (C. B. Fairchild), probably introduced.

THERIDION ADJACENS (O. P. Cambridge)
Figures 111-117; Map 4

Phyllonethis thorellii O. P. Cambridge, 1894, Biologia Centrali Americana, Araneidea, vol. 1, p. 132, pl. 18, fig. 1, ♂ (♂ type from Omilteme, Guerrero, in the British Museum, Natural History).

Phyllonethis adjacens O. P. Cambridge, 1896, *op. cit.*, p. 166, pl. 20, fig. 1, ♀ (♀ type from Omilteme, Guerrero, in the British Museum, Natural History).

Theridion thorellii, F. P. Cambridge, 1902, *ibid.*, vol. 2, p. 390, pl. 36, figs. 28, 29, ♀, ♂. Name preocc. by *T. thorellii* L. Koch, 1865.

Theridion adjacens, Roewer, 1942, Katalog der Araneae, vol. 1, p. 489.

Map 4. Distribution of *Theridion adjacens* (O. P. Cambridge) and *T. antillanum* Simon.

Description. Carapace, sternum, legs yellow. Abdomen white with white pigment covering sides and dorsum; also some black spots on dorsum and above spinnerets. Total length of female 5.6 mm. Carapace 1.9 mm. long, 1.3 mm. wide. First femur, 4.7 mm.; patella and tibia, 4.9 mm.; metatarsus, 5.6 mm.; tarsus, 1.4 m.; second patella and tibia, 2.6 mm.; third, 1.6 mm.; fourth, 3.0 mm. Total length of male 3.4 mm. Carapace 1.3 mm. long, 1.2 mm. wide. First femur, 3.7 mm.; patella and tibia, 4.0 mm.; metatarsus, 4.4 mm.; tarsus, 1.1 mm. Second patella and tibia, 2.3 mm.; third 1.3 mm.; fourth 2.2 mm.

The epigynum, a slitlike depression (Figs. 114, 115, 117) varies in proportions; its dark spots are variable in shape. The tegulum and embolus of the palpus are quite variable in shape.

Records. Nuevo Léon: Chipinque nr. Monterrey (A. M. and L. I. Davis); Horsetail Falls (L. I. Davis). *Durango:* 6 mi. NE. of, 10 mi. E. of El Salto (W. J. Gertsch); *Distrito Federal:* Xochimilco (H. Wagner); Contreras (H. Wagner; J. C. and D. L. Pallister); Santa Rosa (H. Wagner). *Morelos:* 7 mi. N. of Cuernavaca (L. I. Davis); Cuernavaca (N. L. H. Krauss). *Veracruz:* Jalapa (J. C. and D. L. Pallister); Coatepec (C. and P. Vaurie). *Hidalgo:* Apulco (H. Wagner); Chapulhuacán (W. J. Gertsch); 10-20 mi. S. of Jacala (V. Roth, W. J. Gertsch); Alfajayucan, Ixmiquilpan (H. Wagner); Huachinango (C. Goodnight). *Michoacan:* Cerro Tancitaro (H. Hoogstraal); Uruapan (N. L. H. Krauss); Quiroga (R. Dreisbach). *Puebla:* Villa Juárez (H. M. Wagner); Huachinango (H. M. Wagner); 8 mi. S. Teziutlán (C. and P. Vaurie). *Oaxaca:* Oaxaca (B. Malkin; C. and P. Vaurie). *Guatemala:* Lago de Atitlán (C. and M. Goodnight); Chimaltenango, Yepocapa Dept. (H. Elishewitz). *Honduras:* (Von Hagen). *Costa Rica:* Volcán Poás (Tristan); Cartago (N. L. H. Krauss). *Panama:* Boquete: El Volcán (A. M. Chickering); Cerro Punta (N. L. H. Krauss; W. J. Gertsch).

THERIDION COYOACAN, new species
Figures 107-110; Map 2

Type. Male type from Coyoacán, Distrito Federal, Mexico, July 28, 1947 (H. Wagner), in the American Museum of Natural History.

Description. Carapace yellow-white with a median black line on the posterior half, two parallel lines on the anterior meeting the posterior median eyes; border black. Sternum, legs, yellow-white. Abdomen covered by white pigment, except venter; two black spots above spinnerets; dorsum with a few scattered circular black spots. Anterior median eyes a little more than their diameter apart, one-third diameter from laterals in female, three-quarters in male. Posterior median eyes one diameter apart, one and one-third from laterals. Total length of female 3.6 mm. Carapace 1.3 mm. long, 1.2 mm. wide. Second patella and tibia, 1.4 mm.; third, 0.9 mm.; fourth, 1.6 mm. Total length of male 3.3 mm. Carapace 1.4 mm. long, 1.2 mm. wide. First femur, 3.3 mm.; patella and tibia, 3.7 mm.; metatarsus, 3.1 mm.; tarsus, 0.7 mm. Second patella and tibia, 2.3 mm.; third, 1.1 mm.; fourth, 1.7 mm.

Diagnosis. Details of the genitalia (Figs. 107-110), particularly the shape of the palpal embolus, distinguish this species from others of the *frondeum* group.

Records. Chihuahua: Catarinas (W. J. Gertsch). *Durango:* Rodeo (W. J. Gertsch); Palos Colorados, 8000 ft. (W. J. Gertsch); 6 mi. NE. of El Salto (W. J. Gertsch). *Jalisco:* Lagos de Moreno (R. Dreisbach). *Hidalgo:* Apulco (H. Wagner); Ixmiquilpan (H. Wagner); Tenango (H. Wagner). *Distrito Federal:* Coyoacán, ♀, ♂ paratypes (H. Wagner); Xochimilco; Pedregal (H. Wagner); Acolman, 2300 m. (H. Wagner); San Jerónimo (J. C. and D. L. Pallister). *Tlaxcala:* Tlaxcala (V. Roth and W. J. Gertsch). *Guerrero:* Taxco (L. Isaacs). *Oaxaca:* San Felipe (H. Wagner).

THERIDION BARBARAE, new species
Figures 120-123

Type. Male type from Santa Bárbara, Chihuahua, July 18, 1947 (W. J. Gertsch), in the American Museum of Natural History.

Description. Carapace yellow-white with a median dusky line, which is double in front. Legs yellow-white with yellow rings on ends of segments. Abdomen white with four small black spots on dorsum. Anterior eyes of female one and one-third diameters apart, two-thirds from laterals. Posterior median eyes two-thirds diameter apart, one diameter from laterals. Eyes of male slightly smaller and farther apart. Total length of female 2.9 mm. Carapace 1.3 mm. long, 1.0 mm. wide. First femur, 2.0 mm.; patella and tibia, 2.3 mm.; metatarsus, 2.0 mm.; tarsus, 0.7 mm. Second patella and tibia, 1.4 mm.; third, 0.9 mm.; fourth, 1.6 mm. Total length of male 2.9 mm. Carapace 1.3 mm. long, 1.1 mm. wide. Second patella and tibia, 2.5 mm.; third, 1.0 mm.; fourth, 1.9 mm.

Diagnosis. The structure of the tegulum, conductor and embolus (Fig. 121) distinguish this species from *T. sanctus*.

Record. Chihuahua: 22.4 mi. S. of Miñaca (R. Smith).

THERIDION ROTHI, new species
Figures 105-106

Type. Male type from two miles west of Río Frío, 3200 m. Distrito Federal, Mexico, July 24, 1956 (W. J. Gertsch and V. Roth), in the American Museum of Natural History.

Description. Carapace yellow-white with a median dusky band which is widest in front. Legs yellow; ends of segments dusky. Abdomen white with two rows of black spots; venter with a dusky circle surrounding pedicel and genital area. Anterior median eyes almost half the diameter of others. Anterior median eyes a little more than their diameter apart, two-thirds from laterals. Posterior median eyes less than one diameter apart, one and one-quarter from laterals. Total length of a male 2.7 mm. Carapace 1.3 mm. long, 0.9 mm. wide. First femur, 2.2 mm.; patella and tibia, 2.7 mm.; metatarsus, 2.0 mm.; tarsus, 0.8 mm. Second patella and tibia, 1.6 mm.; third, 0.9 mm.; fourth, 1.4 mm.

Diagnosis. The convolutions of the palpal ducts (Fig. 106) differentiate this species from *T. adjacens.*

Records. Hidalgo: Jacala (V. Roth and W. J. Gertsch). *Distrito Federal:* Desierto de los Leones (J. C. and D. L. Pallister). *Mexico:* Ixtapan de la Sal (H. Wagner). *Oaxaca:* Oaxaca (B. Malkin).

THERIDION SANCTUS, new species
Figures 118-119

Type. Male type from Nombre de Dios, Durango, Aug. 17, 1947 (W. J. Gertsch), in the American Museum of Natural History.

Description. Yellow-white except dorsum of abdomen which is white and has at times small black spots. Anterior median eyes a little more than their diameter apart, less than their diameter from laterals. Total length of male 2.3 mm. Carapace 1.2 mm. long, 0.9 mm. wide. First femur, 2.5 mm.; patella and tibia, 2.7 mm.; metatarsus, 2.6 mm.; tarsus, 0.8 mm. Second patella and tibia, 1.5 mm.; third, 0.9 mm.; fourth, 1.5 mm.

Diagnosis. This species differs from *T. barbarae* in the shape of the tegulum of the palpus (Fig. 119).

Records. Durango: Nombre de Dios, ♂ paratype (W. J. Gertsch). *Hidalgo:* Alfajayucan, Ixmiquilpan (H. Wagner); 10-20 mi. S. of Jacala (V. Roth and W. J. Gertsch). *Puebla:* 12 mi. N. of Acatlán (L. I. and A. M. Davis). *Veracruz:* Río Blanca (R. Dreisbach). *Guerrero:* 11 mi. W. of Chilpancingo (W. J. Gertsch and V. Roth). *Chiapas:* Río de las Flores (H. Wagner); Chiapa (H. Wagner).

THERIDION DREISBACHI, new species
Figures 201-202

Type. Male holotype from San Blas, Nayarit, Sept. 14, 1957 (R. Dreisbach), in the Museum of Comparative Zoology.

Description. Carapace yellowish with a median gray band whose sides are parallel. Sternum yellow. Legs yellowish with a black mark on ends of femora and tibiae. Abdomen gray with a median dorsal row of white pigment spots, whose posterior end has a large black spot on each side; black spots on each side of spinnerets. Eyes subequal in size. Anterior median eyes their diameter apart. Posterior median eyes their diameter apart, a little more than a diameter from laterals. Chelicerae with proximal knobs. Total length 2.7 mm. Carapace 1.2 mm. long, 1.0 mm. wide. First femur, 2.8 mm.; patella and tibia, 3.0 mm.; metatarsus, 2.9 mm.; tarsus, 1.0 mm. Second patella and tibia, 1.6 mm.; third, 1.0 mm.; fourth, 1.5 mm.

Diagnosis. The shape of the palpal embolus (Fig. 202) and median apophysis (Fig. 201) separate this species from *Theridion sanctus* and others of the *frondeum* group.

THERIDION CRUCUM, new species
Figures 142-143

Type. Male type from National Park near Las Cruces, Chihuahua, Mexico, June 11, 1941 (A. M. and L. I. Davis), in the American Museum of Natural History.

Description. Carapace, sternum, legs yellow-white. Carapace with a median double line. Dorsum of abdomen white, with a median band which is black in the middle and white towards spinnerets; a pair of black spots above spinnerets. Eyes small: anterior medians slightly smaller than others, two diameters apart, one and one-quarter from laterals. Posterior median eyes one and one-quarter diameters apart, one and one-half from laterals. Total length of male 3.3 mm. Carapace 1.6 mm. long, 1.3 mm. wide. First femur, 2.8 mm.; patella and tibia, 3.2 mm.; metatarsus, 2.9 mm.; tarsus, 0.9 mm. Second patella and tibia, 2.0 mm.; third, 1.1 mm.; fourth, 1.8 mm.

Diagnosis. The narrow palpus with a very long median apophysis (Figs. 142, 143) separates this species from others of the *T. frondeum* group.

Records. Distrito Federal: Santa Rosa (H. Wagner); Desierto de los Leones (C. Goodnight).

THERIDION TRISTANI, new species

Figures 136, 137

Type. Male type from Santa María Dota, Costa Rica (Tristan), in the Museum of Comparative Zoology.

Description. Abdomen with white pigment and two rows of black spots on dorsum and probably a pair of black spots on venter. Anterior median eyes probably one and one-quarter diameters apart, two-thirds from laterals. Posterior eyes one diameter apart. Total length, 3.5 mm. Carapace 1.5 mm. long, 1.3 mm. wide. First femur, 0.43 mm.; patella and tibia, 0.49 mm.; metatarsus, 0.47 mm.; tarsus, 1.4 mm. Second patella and tibia, 0.27 mm.; third, 0.15 mm.; fourth, 0.23 mm.

The only known specimen of this species is in very poor condition; it had been determined as *T. biolleyi* by Banks.

Diagnosis. This species differs from *T. evexum* in the subtegulum of the palpus lacking the median notch and in the embolus having an ectal projection (Fig. 137).

THERIDION EVEXUM Keyserling

Figures 124-135; Map 5

Theridion evexum Keyserling, 1884, Die Spinnen Amerikas, vol. 2, pt. 1, p. 65, pl. 3, fig. 39, ♀ (♀ type from N. Granada, in the British Museum, Natural History). Roewer, 1942, Katalog der Araneae, vol. 1, p. 492.

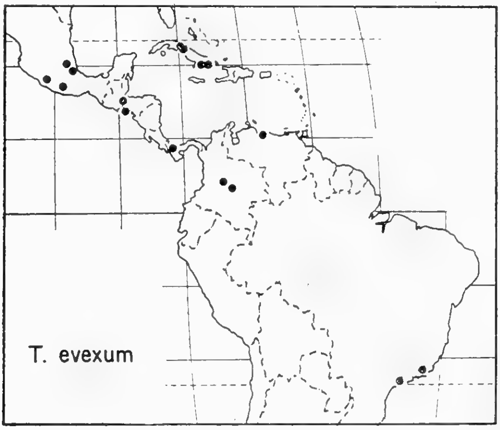
Phyllonethis electa O. P. Cambridge, 1895, Biologia Centrali Americana, Araneidea, vol. 1, p. 165, pl. 20, fig. 2, ♀, ?fig. 3 ♀ (♀ type from

Omilteme, Guerrero, in the British Museum, Natural History).

Theridion electum, F. P. Cambridge, 1902, *ibid.*, vol. 2, p. 390, pl. 36, fig. 27, ♂.

Theridion cabriolatum Franganillo, 1930, Mas Aracnidos Nuevos de Cuba, p. 12, fig. 4, ♀ (♀ types from Sierra Maestra, Cuba). Roewer, 1942, Katalog der Araneae, vol. 1, p. 490. NEW SYNONYMY.

Comment. This large brightly colored species has a dorsal abdominal pattern like *T. pictipes.* The venter of the abdomen has a white spot framed by black stripes similar to the female believed to be *T. omiltemi* (Fig. 174). The long legs have black rings like *Chrysso cambridgei.* It differs from the latter species in having an abdomen of typical shape. The epigynum is a depression (Figs. 125, 127) of variable shape. There is considerable variation in the shape of several palpal sclerites; however, the embolus is similar in all males examined, and the subtegulum has a characteristic notch (Figs. 129, 131, 133, 135).



Map 5. Distribution of *Theridion evexum* Keyserling.

Records. Michoacan: Ian-Itaro, ♀ (Hoogstraal). *Hidalgo:* Chapulhuacan, ♂ (W. J. Gertsch). *Puebla:* Villa Juárez, ♂ (H. M. Wagner). *Veracruz:* La Planta de Moctezuma nr. Fortín, ♀ (C. and M. Goodnight). *Guerrero:* Omiltemi (O. P. Cambridge, 1895). *Guatemala:* Los Amates, ♀, ♂ (Kellerman). *El Salvador:* San Salvador (Kraus, 1955). *Panama:* El Volcán, ♀, ♂ (A. M. Chickering; W. J. Gertsch). *Cuba:* Mts. N. of Imías, 3-4000 ft., ♀; Trinidad Mts., 2500-3500 ft., ♂; S. side of Pico Turquino, ♀, ♂; Sierra del Cobre, 3000-3800 ft., ♀; 5 mi. E. of Soledad, Oriente, ♀ (all P. J. Darlington); Mina Carlota, Trinidad Mts., ♀, ♂ (Salt and Myers); Sierra del Cobre, 2600-3325 ft. (S. C. Bruner). *Colombia:* N. Granada (Keyserling, 1884); Boyaca Prov.: Río Upia, 850-950 m, ♀. *Venezuela:* Rancho Grande, ♀ (W. Beebe). *Brazil:* Est. Rio de Janeiro: Petrópolis, 850-1000 m; ♀ (H. Sick); Cidade São Paulo, ♀ (H. Sick).

THERIDION RICENSE, new species
Figures 138-141

Type. Male holotype from El Yunque, Puerto Rico, Feb. 27-28, 1955 (A. M. Nadler), in the American Museum of Natural History.

Description. Carapace yellow-white with a wide black band in female, a dusky band in male. Sternum, legs yellow-white. Legs with indistinct dark marks. Abdomen yellowish, dorsum spotted with white pigment. Anterior median eyes slightly smaller than others, a little more than a diameter apart, their radius from laterals. Posterior eyes slightly less than their diameter apart. Total length of female 3.8 mm. Carapace 1.4 mm. long, 1.1 mm. wide. First femur, 3.4 mm.; patella and tibia, 3.5 mm.; metatarsus, 3.6 mm.; tarsus, 0.9 mm. Second patella and tibia, 2.1 mm.; third, 1.2 mm.; fourth, 2.4 mm. Total length of male 2.9 mm. Carapace 1.2 mm. long, 1.0 mm. wide. First femur, 3.5 mm.; patella and tibia, 3.6 mm.; metatarsus, 3.6 mm.; tarsus, 1.0 mm. Second patella and tibia, 2.1 mm.; third, 1.1 mm.; fourth, 2.2 mm.

Diagnosis. The epigynum which has a small oval depression, wider than long (Fig. 139), and the median apophysis and tegulum of the palpus (Figs. 140, 141) separate this species from others of the *T. frondeum* group.

THERIDION LEONES, new species
Figures 148-151

Type. Male type from Desierto de los Leones, Distrito Federal, Mexico, May 26, 1946 (J. C. and D. L. Pallister), in the American Museum of Natural History.

Description. Carapace yellow-white with a dusky median stripe which becomes as wide anterior as posterior median eyes; border dusky. Sternum, legs yellow-white; legs with dusky rings on middle and ends of segments. Abdomen with white median dorsal band whose sides are wavy; sides of dorsum black to gray; sides, venter white. Anterior median eyes one diameter apart, two-thirds from laterals. Posterior median eyes one diameter apart, one and one-third from laterals. Total length of a female, 3.3 mm. Carapace 1.2 mm. long, 1.1 mm. wide. First femur, 1.9 mm.; patella and tibia, 2.0 mm.; metatarsus, 1.7 mm.; tarsus, 0.6 mm. Second patella and tibia, 1.3 mm.; third, 0.8 mm.; fourth, 1.4 mm. Total length of a male 2.2 mm. Carapace 1.1 mm. long, 0.9 mm. wide. Second patella and tibia, 1.3 mm.; third, 0.8 mm.; fourth, 1.3 mm.

Diagnosis. The epigynum has a circular to wider than long depression whose lateral walls are heavily sclerotized (Fig. 149). The shorter legs, lack of black mark on the sternum of the female and the shape of the tegulum of the male palpus (Fig. 151) separate this species from *T. contreras.*

Records. Distrito Federal. Desierto de los Leones, ♀, ♂ paratypes (J. C. and D. L. Pallister; C. Goodnight, F. Bonet and Bolivar).

THERIDION CONTRERAS, new species
Figures 144-147

Type. Male type from Contreras, Distrito Federal, Mexico, 2600 m., July 23, 1947 (H. Wagner), in the American Museum of Natural History.

Description. Carapace, sternum, legs whitish in female, darker yellowish in male. Carapace with head dusky. Sternum with a median black line on posterior portion. Legs with distal ends of segments yellow. Abdomen yellow-white, with a median dorsal white band. Male with some black pigment on abdomen. Anterior eyes slightly larger than others in female, subequal in male, their diameter apart, two-thirds from laterals. Posterior median eyes one diameter apart, one and one-half from laterals. Total length of female 3.4 mm. Carapace 1.3 mm. long, 1.1 mm. wide. First femur, 2.7 mm.; patella and tibia, 2.9 mm.; metatarsus, 2.6 mm.; tarsus 0.7 mm. Second patella and tibia, 1.8

mm.; third, 1.0 mm.; fourth, 1.8 mm. Total length of male 2.7 mm. Carapace 1.3 mm. long, 1.2 mm. wide. First femur, 3.1 mm.; patella and tibia, 3.5 mm.; metatarsus, 3.0 mm.; tarsus, 0.9 mm. Second patella and tibia, 2.2 mm.; third, 0.9 mm.; fourth, 1.8 mm.

Diagnosis. The shape of the tegulum of the male palpus (Fig. 147), the longer legs, dusky mark on the sternum and wider epigynum (Fig. 145) differentiate this species from *T. leones.*

Records. Durango: 6 mi. NE. of El Salto (W. J. Gertsch). *Hidalgo:* Apulco (H. Wagner). *Distrito Federal:* Santa Rosa, ♀ paratypes (H. Wagner).

THERIDION METABOLUM Chamberlin and Ivie

Figures 152-158

Theridion niveum, Banks, 1929, Bull. Mus. Comp. Zool., vol. 69, p. 84 (err. det.).

Theridion metabolum Chamberlin and Ivie, 1936, Bull. Univ. Utah, biol. ser., vol. 3, no. 5, p. 33, pl. 10, fig. 79, ♀ (♀ type from Barro Colorado Island, Panama, in the American Museum of Natural History).

Description. Carapace white. Sternum black. Legs white with black rings. Abdomen white with dorsal white and black spots (Fig. 154), venter gray except for black genital area. Anterior median eyes one diameter apart, two-thirds from laterals. Posterior eyes one diameter apart. Total length of females 2.3-3.8 mm. A female measured total length 2.9 mm. Carapace 1.1 mm. long, 1.0 mm. wide. First femur 3.1 mm.; patella and tibia, 3.2 mm.; metatarsus, 3.0 mm.; tarsus, 1.0 mm. Second patella and tibia, 1.7 mm.; third, 0.9 mm.; fourth, 1.6 mm. A male measured total length 2.1 mm. Carapace 1.1 mm. long, 0.8 mm. wide. First femur, 3.2 mm.; patella and tibia, 3.2 mm.; metatarsus, 3.0 mm.; tarsus, 1.0 mm. Second patella and tibia, 1.7 mm.; third, 0.9 mm.; fourth, 1.5 mm.

Records. Panama: El Valle (A. M. Chickering). *Canal Zone:* Experimental Gardens; Summit; Forest Reserve; Madden Dam; Ft. Sherman; Barro Colorado Isl., very common (all A. M. Chickering).

THERIDION NIVEUM O. P. Cambridge

Figures 162-167

Theridion niveum O. P. Cambridge, 1898, Biologia Centrali Americana, Araneidea, vol. 1, p. 255, pl. 34, fig. 11, ♀ (♀ type from Bugaba, Panama, in the British Museum, Natural History). F. P. Cambridge, 1902, *ibid.*, vol. 2, p. 390, pl. 37, figs. 1, 2, ♀, ♂. Roewer, 1942, Katalog der Araneae vol. 1, p. 496. (Not *T. niveum*, Petrunkevitch, 1930, Trans. Connecticut Acad. Sci., vol. 30, p. 204, figs. 51, 52, err. det.)

Description. Carapace, sternum, legs yellow. Abdomen yellowish white, dorsum with white pigment, sometimes with an anterior median black spot or black spots on sides. Anterior median eyes one and one-half diameters apart, one from laterals. Posterior median eyes one diameter apart. Chelicerae with two teeth on anterior margin. Epigynum (Figs. 163, 164) a projecting knob having an opening on each side. Measurements of female total length, 2.5 mm. Carapace, 1.0 mm. long. First femur, 2.0 mm.; patella and tibia, 2.1 mm.; metatarsus, 1.9 mm.; tarsus, 0.8 mm. Second patella and tibia, 1.1 mm.; third, 0.7 mm.; fourth, 1.3 mm. Total length of male 1.6 mm. Carapace, 0.8 mm. long. First femur, 2.4 mm.; patella and tibia, 2.5 mm.; metatarsus, 2.5 mm.; tarsus, 0.7 mm. Second patella and tibia, 1.6 mm.; third, 0.8 mm.; fourth, 1.3 mm.

These descriptions are from males and females from Teapa, Mexico, determined by F. P. Cambridge. The specimens were in poor condition, having probably once been dry. A male of *T. trepidum* determined by F. P. Cambridge proved to be the same species.

Natural History. This species has been collected on bromeliads in Veracruz by Bordas.

Records. San Luis Potosí: 23 mi. S. of Ciudad de Valles (A. M. and L. I. Davis); Xilitla (R. Dreisbach). *Veracruz:* Martínez de la Torre, 45 m. (H. Wagner); Córdoba (J. C. and D. L. Pallister); Tlacotalpan (H. Wagner); La Buena Ventura (A. Petrunkevitch); Tuxtilla (H. Wagner); Mantla; Yanaa (Bordas). *Guerrero:* Amula, Omiltemi (O. P. Cambridge). *Oaxaca:* Papaloapan (H. Wagner). *Chiapas:* El Real (C. and M. Goodnight); Puerto Madero (N. L. H. Kraus).

THERIDION EXCAVATUM F. P. Cambridge
Figures 206-207

Theridion excavatum F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, pl. 37, fig. 5, ♀ (♀ type from Guatemala, in the British Museum, Natural History). Roewer, 1942, Katalog der Araneae, vol. 1, p. 492.

THERIDION UNCATUM F. P. Cambridge
Figures 203-204

Theridion uncatum F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 390, pl. 37, fig. 3, ♂ (♂ type from Omilteme, Guerrero, in the British Museum, Natural History). Roewer, 1942, Katalog der Araneae, vol. 1, p. 500.

THERIDION STYLIGERUM F. P. Cambridge
Figures 168-171

Theridion styligerum F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 389, pl. 36, fig. 24, ♂ (♂ type from Guatemala, in the British Museum, Natural History).

Description. Carapace yellow-white with a median dusky band which splits in two anteriorly, each branch touching a posterior median eye. Legs yellow-white, banded in male. Abdomen yellow-white, dorsum white with two black spots above spinnerets; often a pair of black spots on venter. Anterior median eyes one and one-half diameters apart, one and three-quarters from laterals. Posterior median eyes one diameter apart, one and three-quarters from laterals. Total length of female 3.2 mm. Carapace 1.3 mm. long, 1.2 mm. wide. First femur, 2.6 mm.; patella and tibia, 2.7 mm.; metatarsus, 2.7 mm.; tarsus, 0.9 mm. Second patella and tibia, 1.6 mm.; third, 1.1 mm.; fourth, 1.9 mm. The epigynum has an oval depression (Fig. 169); the embolus of the palpus is enlarged (Fig. 171).

Natural History. This species has been found in oak forest at 7200 ft. in Veracruz.

Records. Durango: 30 mi. NE., 10 mi. E., 6 mi. NE. of El Salto (W. J. Gertsch). *Veracruz:* nr. Acultzingo (C. Goodnight). *Hidalgo:* Apulco (H. Wagner); 10-20 mi. S. of Jacala (V. Roth, W. J. Gertsch). *Distrito Federal:* Santa Rosa (H. Wagner); Contreras, 2600 m. (H. Wagner); Xochimilco (C. Goodnight; H. Wagner); Coyoacan (H. Wagner); Tlalpam, 2300 m. (H. Wagner). *Puebla:* Teciutlan (C. and P. Vaurie). *Morelos:* nr. Cuernavaca, 8700 ft. (R. Dreisbach). *Oaxaca:* (B. Malkin). *Guatemala:* Chichicastenango (C. and P. Vaurie); Nebaj (C. and P. Vaurie).

THERIDION TREPIDUM O. P. Cambridge
Figures 177-180

Theridion trepidum O. P. Cambridge, 1898, Biologia Centrali Americana, Araneidea, vol. 1, p. 256, pl. 34, fig. 10, ♂ (♂ type from Montaña de Chilascó, Guatemala, in the British Museum, Natural History). F. O. P. Cambridge, *ibid.*, 1902, vol. 2, p. 391, pl. 37, fig. 4, ♂. Roewer, 1942, Katalog der Araneae, vol. 1, p. 499.

Phyllonethis trepidum O. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 1, p. 307, pl. 39, fig. 9, ♀.

Description. Carapace, sternum, legs yellow white; carapace with a median dusky double line. Legs of male with dark rings. Dorsum of abdomen white usually with a pair of black bands, irregular in outline, about their width apart. Anterior median eyes one and three-quarters diameters apart, one diameter from laterals. Posterior eyes one and one-quarter diameters apart. Anterior median eyes slightly smaller than others. Total length of female 2.4 mm. Carapace 0.85 mm. long, 0.75 mm. wide. First femur, 2.16 mm.; patella and tibia, 2.18 mm.; metatarsus, 2.10 mm.; tarsus, 0.69 mm. Second patella and tibia, 1.28 mm.; third, 0.75 mm.; fourth, 1.37 mm. The epigynum has an oval depression (Fig. 178). The male can be identified by its palpus (Figs. 179, 180).

Records. Hidalgo: Rancho Viejo nr. Jacala (C. and M. Goodnight). *Distrito Federal:* Santa Rosa (H. Wagner); Desierto de los Leones (C. Goodnight). *Puebla:* ?Tehiutaitlan (H. Wagner). *Oaxaca:* Oaxaca. *Chiapas:* Tenejapa (C. Goodnight); Las Casas (C. and M. Goodnight and L. Stannard); San Cristóbal de las Casas (C. and M. Goodnight; H. Wagner). *Panama:* El Volcán (W. J. Gertsch).

THERIDION MARTINI, new species
Figures 181-182

Type. Male type from Volcan San Martín, near San Andrés, Veracruz, 5000 ft., July 14, 1948 (C. J. Goodnight), in the American Museum of Natural History.

Description. Carapace, sternum, legs bright yellow. Abdomen light gray with four small dark spots on dorsum. Anterior median eyes slightly smaller than others, less than one diameter apart, one-third from laterals. Posterior median eyes one diameter apart, two-thirds from laterals. Total length of male 2.5 mm. Carapace 1.3 mm. long, 1.1 mm. wide. First femur, 2.3 mm.; patella and tibia, 2.7 mm.; metatarsus, 2.1 mm.; tarsus, 0.9 mm. Second patella and tibia, 1.8 mm.; third, 1.3 mm.; fourth, 1.7 mm.

Diagnosis. The heavy median apophysis of the palpus (Figs. 181, 182) separates this species from others of the *T. frondeum* group.

THERIDION OMILTEMI, new species
Figures 172-176

Theridion evexum, F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 389, pl. 36, fig. 25, ♂, ♀ (err. det.).

Type. Male type from Omiltemi, Guerrero, in the British Museum (Natural History).

Description. Carapace brownish yellow. Chelicerae brown. Maxillae, sternum dark brown. Legs yellow with dark spots on distal ends of segments. Abdomen white with an anterior median dorsal black patch and a pair of black patches on posterior which are continuous with black venter (Fig. 174); venter of male dusky yellow. Anterior median eyes one diameter apart, slightly more in female, two-thirds their diameter in male. Posterior median eyes almost one diameter apart, one and one-third from laterals. Total length of female 5.8 mm. Carapace 2.2 mm. long, 1.4 mm. wide. First femur, 6.3 mm.; patella and tibia, 5.5 mm.; metatarsus, 6.8 mm.; tarsus, 1.5 mm. Second patella and tibia, 3.6 mm.; third, 2.2 mm.; fourth, 4.0 mm. Total length of male 3.6 mm. Carapace 1.7 mm. long, 1.2 mm. wide. First femur, 5.0 mm.; patella and tibia, 4.3 mm.; metatarsus, 5.8 mm.; tarsus, 1.3 mm. Second patella and tibia, 2.7 mm.; third, 1.4 mm.; fourth, 2.5 mm.

Differences in coloration might suggest that the female does not belong to the male.

Diagnosis. The median apophysis of the palpus (Fig. 175) distinguishes this species from *T. evexum*.

Record. Guatemala: San Jerónimo (C. and P. Vaurie).

THERIDION GRECIA, new species
Figures 185-186

Type. Female type from Grecia, Costa Rica, Nov. 22, 1955 (B. Malkin), in the American Museum of Natural History.

Description. Carapace whitish with a median dusky line. Legs whitish with distal end of first tibiae and middle and distal end of metatarsi black. Abdomen yellow-white with a median dorsal white band and a white band on each side. Anterior median eyes a little more than one diameter apart, one diameter from laterals. Posterior eyes slightly more than one diameter apart. Total length of female, 2.9 mm. Carapace, 1.0 mm. long, 0.9 mm. wide. First femur, 2.2 mm.; patella and tibia, 2.2 mm.; metatarsus, 1.9 mm.; tarsus, 0.7 mm. Second patella and tibia, 1.2 mm.; third, 0.9 mm.; fourth, 1.5 mm.

Diagnosis. The epigynum whose openings are on the anterior face of a heavily sclerotized slight elevation (Fig. 186) distinguishes this species from others of the *frondeum* group.

Records. Nayarit: Tepic (C. and M. Goodnight). *Chiapas:* nr. Río San Gregorio, betw. Comitán and Ocotal (C. and M. Goodnight); 30 km. NE. of Cintalapa (H. Wagner). *Costa Rica:* Grecia, ♀ paratype (B. Malkin). *Panama:* El Valle (A. M. Chickering). *Venezuela:* Botanical Gardens, Caracas (A. M. Nadler).

THERIDION BIOLLEYI Banks
Figures 195-196

Theridion biolleyi Banks, 1909, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, p. 204, pl. 6, fig. 26, ♀ (♀ type from Tablazo, Costa Rica, in the Museum of Comparative Zoology).

Description. Carapace yellow-white with a dusky median band, as wide as eyes in front with a narrow dusky cross band. Sternum dusky. Legs yellow-white with bands. Abdomen with an indistict white median band, sides mottled gray; a black diagonal mark on each side. Venter with a pair of black spots on the side of a larger white spot. Anterior median eyes one and one-half diameters apart, one diameter from laterals. Posterior median eyes one diameter apart, one and one-half from laterals. Epigynum with a heavily sclerotized groove (Fig. 196). Total length of female, 3.6 mm. Carapace 1.8 mm. long, 1.5 mm. wide. First femur, 3.2 mm.; patella and tibia, 3.6 mm.; metatarsus, 3.0 mm.; tarsus, 1.3 mm. Second patella and tibia, 2.2 mm.; third, 1.5 mm.; fourth, 2.6 mm.

THERIDION VULVUM, new species
Figures 197-198

Type. Female holotype from El Valle, Panama, July 1936 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, sternum, legs yellow. Legs with distal ends of segments brown. Abdomen with a median dorsal white band on dusky background; sides with several large white spots. Anterior median eyes their diameter apart, two-thirds from laterals. Posterior median eyes one diameter apart, a little more than one from laterals. Total length of female 2.7 mm. Carapace 1.11 mm. long, 0.92 mm. wide. First femur, 1.85 mm.; patella and tibia, 1.96 mm.; metatarsus, 1.46 mm.; tarsus, 0.72 mm. Second patella and tibia, 1.29 mm.; third, 0.87 mm.; fourth, 1.40 mm.

Diagnosis. The heavily sclerotized epigynum (Fig. 198) differentiates this species from other species of the *T. frondeum* group.

Record. Panama: El Valle, ♀ paratypes (A. M. Chickering); El Volcán (W. J. Gertsch).

THERIDION HONDURENSE, new species
Figures 193-194

Type. Female type from Honduras, 1940 (Von Hagen), in the American Museum of Natural History.

Description. Carapace, sternum, legs yellow-white. Legs yellow at distal ends of tibiae one and four. Abdomen with three dorsal white stripes; area in between narrower than stripes; two black spots above spinnerets. Anterior median eyes smaller than others, one and one-half diameters apart, one diameter from laterals. Posterior eyes a little more than a diameter apart. Total length, 3.7 mm. Carapace 1.5 mm. long, 1.3 mm. wide. First femur, 3.5 mm.; patella and tibia, 3.5 mm.; metatarsus, 3.6 mm.; tarsus, 0.9 mm. Second patella and tibia, 2.2 mm.; third, 1.3 mm.; fourth, 2.4 mm.

Diagnosis. The epigynum having the openings on the anterior surface of a slight knob (Fig. 194) differentiates this species from others.

Record. Honduras: ♀ paratype (Von Hagen).

Theridion bolivari, new species

Figures 189-190

Type. Female type from Desierto de los Leones, Distrito Federal, Mexico, Aug. 5, 1946 (C. Goodnight, Bolivar and Bonet), in the American Museum of Natural History.

Description. Carapace golden yellow with a black band as wide as posterior median eyes in front, narrower behind, border with a narrow black line and two black lines across clypeus. Sternum golden yellow. Legs yellow with black bands or lines on venter at middle and distal ends of segments. Dorsum and sides of abdomen covered by small white pigment spots; two lines of black patches on dorsum converging towards spinnerets. Venter with a black semicircular band anterior to pedicel, a black band across epigynum and a black spot behind genital furrow. Anterior median eyes slightly larger than others, three-quarters diameters apart, one-quarter from laterals. Posterior medians three-quarters diameter apart, one diameter from laterals. Total length of female 3.7 mm. Carapace 1.5 mm. long, 1.4 mm. wide. First femur, 2.2 mm.; patella and tibia, 2.5 mm.; metatarsus, 1.8 mm.; tarsus, 0.8 mm. Second patella and tibia, 1.8 mm.; third, 1.3 mm.; fourth, 1.9 mm.

Diagnosis. The structure of the epigynum (Fig. 190) differentiates this species from other *Theridion.*

Theridion chihuahua, new species

Figures 191-192

Type. Female type from Santa Bárbara, Chihuahua, July 18, 1947 (W. J. Gertsch), in the American Museum of Natural History.

Description. Carapace, sternum, legs yellow-white. Carapace with two fine parallel median lines. Abdomen white. Anterior median eyes their diameter apart, two-thirds diameter from laterals. Posterior median eyes one diameter apart, a little more than one from laterals. Total length of female 3.0 mm. Carapace 1.3 mm. long, 1.1 mm. wide. Second patella and tibia, 1.5 mm.; third, 1.1 mm.; fourth, 1.8 mm.

Diagnosis. The epigynum of this species (Fig. 192) resembles that of *T. arizonense,* but it differs in having two dark posterior areas. The internal genitalia (Fig. 191) are very different and indicate that this species belongs to the *T. frondeum* group.

THERIDION APULCO, new species
Figures 187-188

Type. Female type from Apulco, Hidalgo, Oct. 6, 1947 (H. Wagner), in the American Museum of Natural History.

Description. Carapace whitish with a broad median black band. Clypeus dusky. Sternum, legs whitish with dark rings on distal ends of tibiae. Dorsum of abdomen with an irregular white band on each side; a white stripe above spinnerets which continues mottled and darker anteriorly. Black in between median and lateral stripes. Sides and venter yellowish with some indistinct dusky markings. Anterior median eyes slightly smaller than others one diameter apart, one-third of a diameter from laterals. Posterior median eyes three-quarters diameter apart, one diameter from laterals. Total length of female 2.2 mm. Carapace 1.04 mm. long; 0.89 mm. wide. First femur, 1.96 mm.; patella and tibia, 2.09 mm.; metatarsus, 1.62 mm.; tarsus, 0.75 mm. Second patella and tibia, 1.27 mm.; third, 0.70 mm.; fourth, 1.38 mm.

Diagnosis. This species, which has a median depression on the epigynum (Fig. 188), differs from *T. evexum* by its smaller size, coloration of the venter and internal genitalia (Fig. 187).

Record. Veracruz: Huatusco (H. M. Wegener).

THERIDION TURRIALBA, new species
Figures 183-184

Type. Female type from Turrialba, Costa Rica, April 10-17, 1944 (F. Schrader), in the American Museum of Natural History.

Description. Carapace, sternum, legs yellow-white. Sternum with a dusky median stripe. Legs with black rings on distal ends of first tibiae. Abdomen whitish, with a white median dorsal band, which becomes narrower toward spinnerets; three white patches on each side. Eyes small. Anterior median eyes slightly smaller than others one and one-half diameters apart, one from laterals. Posterior eyes slightly more than their diameter apart. Total length of female 3.0 mm. Carapace 0.97 mm. long, 0.88 mm. wide. First femur, 2.34 mm.; patella and tibia, 2.34 mm.; metatarsus, 2.18 mm.; tarsus, 0.81 mm. Second patella and tibia, 1.30 mm.; third, 0.78 mm.; fourth, 1.40 mm.

Diagnosis. The epigynum is less sclerotized (Fig. 184) than that of *T. metabolum.*

Record. Costa Rica: Turrialba, May 1944 (F. Schrader).

THERIDION FRIO, new species
Figures 199-200

Type. Female type from two miles west of Río Frío, 3200 m., Distrito Federal, Mexico, July 24, 1956. (W. J. Gertsch and V. Roth), in the American Museum of Natural History.

Description. Carapace, sternum, legs whitish. Abdomen white except for two black stripes above and radiating from spinnerets and a pair of black spots on venter. Anterior median eyes one and one-quarter diameters apart, one diameter from laterals. Posterior median eyes one diameter apart, one and one-half from laterals. Total length of female 4.0 mm. Carapace, 1.4 mm. long, 1.3 mm. wide. First femur, 2.6 mm.; patella and tibia, 2.7 mm.; metatarsus, 2.4 mm.; tarsus, 0.8 mm. Second patella and tibia, 1.5 mm.; third 1.1 mm.; fourth, 1.9 mm.

This female was collected with a male of *T. rothi.*

Diagnosis. The heavily sclerotized epigynum (Fig. 200) differentiates this species from others of the *T. frondeum* group.

THERIDION MORULUM O. P. Cambridge
Figures 159-161

Theridion morulum O. P. Cambridge, 1898, Biologia Centrali Americana, Araneidea, vol. 1, p. 254, pl. 35, fig. 6, ♀. (♀ types from Omilteme, Guerrero, in the British Museum, Natural History.) Roewer, 1942, Katalog der Araneae, vol. 1, p. 495.

Steatoda morula, F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 384, pl. 36, fig. 14, ♀.

Theridion jeanae Gertsch and Archer, 1942, Amer. Mus. Novitates, no. 1171, p. 7, figs. 25, 26. (♂ holotype from Santa Catalina Mts., Arizona, in the American Museum of Natural History.) Levi, 1957, p. 79. NEW SYNONYMY.

Description. Carapace yellow. Sternum, legs, dusky yellow. Abdomen black with some dorsal median light stripes and two pairs of diagonal lines. Venter dark gray. Anterior portion of sides very light. Anterior median eyes one diameter apart, one-quarter diameter from laterals. Posterior median eyes less than one diameter apart, one diameter from laterals. Clypeus projecting below eyes. Abdomen nearly spherical, as wide as long, height less than length. Epigynum (Figs. 160, 161) cone shaped, cone black, the tip slightly lighter. Measurements of female, total length, 3.3 mm. Carapace, 1.30 mm. long, 1.17 mm. wide. First femur, 2.02 mm.; patella and tibia, 2.28 mm.; metatarsus, 1.56 mm.; tarsus, 0.78 mm. Second patella and tibia, 1.56 mm.

Theridion morulum is much darker than *jeanae*, and the median apophysis is of slightly different shape. Although this is undoubtedly one species, *jeanae* might well be used as a subspecies.

Records. Morelos: Cuernavaca (W. J. Gertsch, V. Roth); Oaxtepec (C. Bolivar). *Puebla:* Tlacotepec (W. J. Gertsch, V. Roth).

Miscellaneous species of *Theridion*

The species related to *T. positivum* (*istokpoga, cazieri,* and *sinaloa*) are probably close to *T. frondeum;* however, the abdomen tends to be wider than long as in many other species put in this group.

Miscellaneous species found in this region and also occurring north of Mexico, illustrated in a previous paper (1957, Bull. Amer. Mus. Nat. Hist., vol. 112) are:

THERIDION RUFIPES Lucas

Theridion rufipes, Levi, 1957, p. 56, figs. 188-193, ♀, ♂, Map 18.

Distribution. Cosmotropical, but uncommon wherever found in the region under consideration.

Additional records. Panama: El Valle; Boquete (A. M. Chickering). *Cuba:* Soledad, Cienfuegos (Parsons; Salt and Myers); Vilcher's Cave, Soledad (L. G. Worley). *Puerto Rico:* Aguadilla (R. Turner). *Venezuela:* Caracas (A. M. Nadler); Rancho Grande (W. Beebe).

THERIDION ADAMSONI Berland

Theridion adamsoni Berland, 1935, Bull. B. P. Bishop Museum, no. 113, p. 102, figs. 6-9, ♀ (♀ syntypes from Hitiaa, Tahiti, in the B. P. Bishop Museum, Honolulu).

Theridion hobbsi Gertsch and Archer, 1942, Amer. Mus. Novitates, no. 1171, p. 5, fig. 6, ♀ (♀ type from Florida, in the American Museum of Natural History). Levi, 1957, p. 62, figs. 198, 199, 209, 213, 214, ♀, ♂, map 28. NEW SYNONYMY.

Theridion insulicola Bryant, 1947, Psyche, vol. 54, p. 88, fig. 1, ♀. (♀ type from Mona Island, West Indies, in the Museum of Comparative Zoology). NEW SYNONYMY.

Dr. Gertsch first noticed this synonymy. The type of *T. adamsoni* was examined.

Distribution. Cosmotropical.

Additional records. Canal Zone: Summit (A. M. Chickering). *Venezuela:* Maracay (A. M. Nadler).

THERIDION ATROPUNCTATUM Petrunkevitch

Wamba congener O. P. Cambridge, 1896, Biologia Centrali Americana, Araneidea, vol. 1, p. 191, pl. 24, fig. 1, ♂ (♂ type from Chicoyoito, Guatemala, in the British Museum, Natural History). Name preoccupied by *Theridion congener* O. P. Cambridge, 1863. NEW SYNONYMY.

Theridion atropunctatum Petrunkevitch, 1930, Trans. Connecticut Acad. Sci., vol. 30, p. 210, figs. 59, 60, ♀ (♀ type from Arecibo, Puerto Rico, in the American Museum of Natural History). Levi, 1957, p. 66, figs. 225-228, 232-234, ♀, ♂, map 21.

Crustulina congener, Roewer, 1942, Katalog der Araneae, vol. 1, p. 399. NEW SYNONYMY.

Theridion brevipalpus Bryant, 1942, Bull. Mus. Comp. Zool., vol. 89, p. 341, figs. 28, 31, 32, ♂ (♂ type from St. Croix, Virgin Islands, in the Museum of Comparative Zoology).

The leg length of some males seems to be shorter than others; this might be correlated with heavier sclerotization. Males from Central America have a spine on the cymbium as in *T. crispulum* but the spine is smaller and on the side of the cymbium. Females have the epigynum with a more or less circular depression having a dark spot on each side. The very short connecting ducts separate it from *T. crispulum.*

Distribution. Florida, Yucatan, Bimini, Puerto Rico, Virgin Isl. and Central America.

Additional records. Yucatan: Chichén Itzá (C. Goodnight). *Panama:* Arraiján (A. M. Chickering). *Canal Zone:* Summit; Barro Colorado Isl. (several records); Experimental Gardens; Balboa; Forest Reserve (A. M. Chickering). *Jamaica:* Discovery Bay; St. Ann's Bay; Holland Bay; S. W. of Unity Valley; St. Catharine; Kinloss; Lyssons (all A. M. Nadler). Hardwar Gap, Blue Mts.; Kingston; St. Thomas Par. *Dominican Rep.:* Loma Vieja, Cord. Central (P. J. Darlington); La Matica, Boca Chica (A. M. Nadler); Ciudad Trujillo (A. M. Nadler). *Puerto Rico:* Cidra, Treasure Isl.; Port Grila, San Germán; Mayaguez (all A. M. Nadler). *Virgin Isl.:* St. Croix (Beatty; A. M. Nadler). *Lesser Antilles:* Antigua; St. John. Guadeloupe: Pointe-a-Pitre. Martinique: Fond la Hage. Trinidad: Piarco (all A. M. Nadler). *Venezuela:* Maracay; Caracas (A. M. Nadler).

THERIDION CRISPULUM Simon

Theridion crispulum Simon, 1895, Ann. Ent. Soc. France, vol. 64, p. 142 (♀ type from La Guiara, Venezuela, in the Museum National d'Histoire Naturelle, Paris).

Theridion intervallatum Emerton, 1915, Trans. Connecticut Acad. Sci., vol. 20, p. 136, pl. 1, fig. 1, ♂ (♂ type from Intervale, New Hampshire, in the Museum of Comparative Zoology). Levi, 1957, p. 64, figs. 222-224, 229-231, ♀, ♂, map 21. NEW SYNONYMY.

The type specimens of *T. crispulum* examined were marked as coming from San Esteban, Venezuela.

The spine on the cymbium of the male palp is at or close to the tip; frequently the cymbium is drawn out to the spine. The connecting ducts are much longer than those of *T. atropunctatum;* sometimes they open close together, at other times farther apart. There also seem to be differences in the thickness of the ducts.

Distribution. New Hampshire, southeastern United States, eastern Mexico to Central America, Lesser Antilles.

Additional records. Panama: El Volcán (A. M. Chickering). *Canal Zone:* Barro Colorado Isl.; Forest Reserve; Summit; La Boca; Ft. Sherman (A. M. Chickering). *Jamaica:* Hope Gardens; Hermitage Reservoir; Mt. James, St. Andrew Par. (A. M. Chickering). *Lesser Antilles:* Aruba: Oranjestad, ♂ (A. M. Nadler). Trinidad: nr. Port of Spain (R. Thaxter). *Venezuela:* San Esteban.

THERIDION ISTOKPOGA Levi

Theridion istokpoga Levi, 1957, p. 67, figs. 235, 236, 247, 248, ♀, ♂, map 22.

The only female found in Central America has the posterior rim of the epigynum wider than Florida specimens; the openings are thus much closer to the posterior end of the depression. The legs are white with black spots on the venter.

Distribution. Florida, Chiapas and Canal Zone.

Additional record. Canal Zone: Summit, Aug. 1950, ♀ (A. M. Chickering).

THERIDION POSITIVUM Chamberlin

Theridion positivum Chamberlin, 1924, Proc. California Acad. Sci., ser. 4, vol. 12, p. 636 (♀ type from Pond Island, Gulf of California, in the California Academy of Science). Levi, 1957, p. 68, figs. 237-239, 243-246, ♀, ♂, map 22.

Theridion cybele Bryant, 1942, Bull. Mus. Comp. Zool., vol. 89, p. 342, fig. 39, ♀ (♀ type from St. Croix, Virgin Islands, in the Museum of Comparative Zoology).

Specimens examined from Central America have the embolic thread more curved and the posterior border of the depression of the epigynum more straight, than specimens from the north.

Distribution. Southern California, southern Texas, Mexico, Central America and Bimini Isl. in the Greater Antilles.

Additional records. Canal Zone: Experimental Gardens; Summit; Chilibre (all A. M. Chickering). *Cuba:* San Vicente, Pinar del Río (C. and P. Vaurie). *Jamaica:* Kingston; Lyssons; Negrill; Holland Bay (all A. M. Nadler); St. Thomas Par.; St. James Par.; St. Andrew Par. (A. M. Chickering). *Puerto Rico:* Mayaguez; La Matica, Boca Chica (all A. M. Nadler). *Lesser Antilles:* Antigua: St. John (A. M. Nadler). *Venezuela:* Maracay (A. M. Nadler).

THERIDION ALBULUM O. P. Cambridge.

Figures 213-215

Theridion albulum O. P. Cambridge, 1898, Biologia Centrali Americana, Araneidea, vol. 1, p. 255, pl. 34, fig. 9, ♀ (♀ type from Bugaba, Panama, lost). Roewer, 1952, Katalog der Araneae, vol. 1, p. 489.

In general appearance this species is very much like the two preceding and can easily be confused. It differs, however, in the shape of the base of the palpal embolus (Fig. 215) and in having two dark sclerotized plates in the depression of the epigynum (Fig. 214). The depression of the epigynum is usually filled with a white substance, which has to be removed before examination.

Records. Canal Zone: Summit; Forest Reserve; Boquete; Arraiján (A. M. Chickering).

THERIDION CAZIERI, new species.
Figures 216-218

Type. Male type from South Bimini, Bahama Islands, June 1951 (M. A. Cazier), in the American Museum of Natural History.

Description. Carapace yellow-white with an irregular dusky median band which is widest in front and has two large yellow white spots behind eyes. Eye region, clypeus, median portions of chelicerae black. Sternum, legs yellow-white. Legs with many brown and black spots. Abdomen white with black spots; a median dorsal white band; several black streaks above spinnerets. Anterior median eyes their diameter apart, almost touching laterals. Posterior median eyes their radius apart, two-thirds diameters from laterals. Total length of female 3.1 mm. Carapace 1.1 mm. long, 1.0 mm. wide. First femur, 2.2 mm.; patella and tibia, 2.6 mm.; metatarsus, 2.0 mm.; tarsus, 0.8 mm. Second patella and tibia, 1.6 mm.; third, 0.9 mm.; fourth, 1.6 mm. Total length of male 2.7 mm. Carapace 1.3 mm. long, 1.1 mm. wide. First femur, 3.0 mm.; patella and tibia, 3.5 mm.; metatarsus, 3.0 mm.; tarsus, 0.9 mm. Second patella and tibia, 2.3 mm.; third, 1.2 mm.; fourth, 1.8 mm.

Diagnosis. The genitalia (Figs. 217, 218) differentiate this species from *T. positivum* Chamberlin.

Record. Bahama Isl.: South Bimini, ♀, May 1951 (W. J. Gertsch, M. A. Cazier).

THERIDION SINALOA, new species
Figure 212

Type. Male type from north section of Mazatlán, Sinaloa, 1956 (A. F. Archer), in the American Museum of Natural History.

Description. Carapace yellow-white. Sternum white with a dusky border. Legs white with some black spots. Abdomen light covered with white pigment and some dusky spots and two dusky lines converging towards spinnerets on dorsum. Anterior median eyes slightly larger than others, two-thirds diameter apart, touching laterals. Posterior eyes two-thirds diameter apart. Total length of male 1.2 mm. Carapace 0.55 mm. long, 0.50 mm. wide. First femur, 0.91 mm.; patella and tibia, 1.02 mm.; metatarsus, 0.70 mm.; tarsus, 0.39 mm. Second patella and tibia, 0.69 mm.; third, 0.44 mm.; fourth, 0.62 mm.

Diagnosis. The shape of the embolus (Fig. 212) separates this species from *T. positivum.*

Record. Sinaloa: Mazatlán, ♂ paratype (A. F. Archer).

THERIDION ANTILLANUM Simon
Figures 223-226; Map 4

Theridion antillanum Simon, 1894, Proc. Zool. Soc. London, p. 522, fig. 2, ♂ (♀, ♂ syntypes from St. Vincent Isl., Lesser Antilles, in the British Museum, Natural History).

Spintharus minutus Petrunkevitch, 1926, Trans. Connecticut Acad. Sci., vol. 28, p. 51, fig. 11, ♀ (♀ type from St. Thomas, Virgin Isl.). NEW SYNONYMY.

Theridion dexteri Petrunkevitch, 1930, *ibid.*, vol. 30, p. 200, figs. 45-50, ♀, ♂ (6 ♀, 1 ♂ syntype from University Campus, Rio Piedras, Porto Rico). NEW SYNONYMY.

Comments. The embolus of the palpus is on the mesal side (Fig. 225). The radix seems absent; it has probably been lost secondarily as a result of the shifting of other sclerites. The ventral ducts of the epigynum (Figs. 223, 224) which form a rough rectangle or oval are sometimes wider apart, sometimes closer together; the seminal receptacles may be visible through the epigynum at times. The dark areas (coil of the duct), on each side in the epigynum, readily distinguish this species from other small *Theridion* lacking pigment.

Specimens determined by Simon were examined.

Natural History. It has been collected from leaves of cocoanut palms (Petrunkevitch, 1930).

Records. Bahama Isl.: South Bimini (A. M. Nadler, W. J. Gertsch; M. A. Cazier); New Providence Isl. (E. B. Hayden); West Caicos Isl. (E. B. Hayden). *Jamaica:* St. Thomas Par.;

Trelawny Par.; Hanover Par.; St. James Par.; St. Andrew Par. (many records); Manchester Par. (A. M. Chickering); St. Catherine Par. (A. M. Chickering); Holland Bay (A. M. Nadler); Lyssons (A. M. Nadler); Kinloss (A. M. Nadler); Negrill (A. M. Nadler); Kingston (A. M. Chickering). *Dominican Rep.:* Roseau; Valle de Polo. *Puerto Rico:* (Petrunkevitch, 1930); Maricao Forest, 2500 ft. (P. J. Darlington); San Juan; Cidra, Treasure Isl. (A. M. Nadler); Mayaguez (A. M. Nadler); *Virgin Isl.:* (Petrunkevitch, 1926); St. Croix (H. A. Beatty; C. E. Wilson; F. E. Lutz). *Lesser Antilles:* Guadeloupe: Point-a-Pitre (A. M. Nadler); Martinique: Fond la Haye (A. M. Nadler); St. Vincent Isl.: (Simon, 1894).

THERIDION JAMAICENSE, new species
Figures 219-222

Type. Male holotype from Dolphin Head Trail, Hanover Parish, Jamaica, June 24, 1954, in the Museum of Comparative Zoology.

Description. Yellow-white without marks. Reported to be grass-green when alive. Eyes small. Anterior medians of female almost two diameters apart, two-thirds from laterals, of male one diameter apart, one-quarter from laterals. Posterior medians two diameters apart, one from laterals. Abdomen sometimes wider than long. Total length of female 2.0 mm. Carapace 0.85 mm. long; 0.65 mm. wide. First femur, 1.62 mm.; patella and tibia, 1.56 mm.; metatarsus, 1.43 mm.; tarsus, 0.52 mm. Second patella and tibia, 1.06 mm.; third, 0.59 mm.; fourth, 1.14 mm. Total length of male 1.7 mm. Carapace, 0.91 mm. long, 0.75 mm. wide. First femur, 1.56 mm.; patella and tibia, 1.56 mm.; metatarsus, 1.30 mm.; tarsus, 0.47 mm. Second patella and tibia, 1.00 mm.; third, 0.65 mm.; fourth, 0.94 mm.

Diagnosis. The female of this peculiar species has a scape on the epigynum (Figs. 220, 221) which reminds one of linyphiid spiders. The palpus is quite translucent and the various sclerites are lobed. The dark portion on the right edge of the palpus (Fig. 222) is the embolus; on the left the sclerotized portion is the median apophysis. This specices is believed to be related to *T. antillanum.* The genitalia distinguish the two speccies.

Natural History. This species is found on vegetation.

Records. Jamaica: Dolphin Head Trail, Hanover Par., ♀ paratype; Dolphin Head, 1600 ft. (G. R. Procter); Hermitage, St. Andrew Par. (Bengra); Grier Mtn., 2300 ft., St. Catherine Par. (G. R. Procter); St. Ann Par. (A. M. Nadler).

THERIDION NUDUM, new species
Figures 227-229

Type. Male type from El Volcán, Panama, Aug. 9-14, 1950 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Yellow-white, lacking pigment except for a black spot on thoracic depression. Anterior median eyes slightly smaller than others, two diameters apart, three-quarters from laterals. Posterior median eyes one and three-quarters diameters apart, one from laterals. Total length of females 1.5-2.2 mm. A female measured total length 2.1 mm. Carapace 0.79 mm. long, 0.71 mm. wide. First femur, 1.36 mm.; patella and tibia, 1.36 mm.; metatarsus, 1.06 mm.; tarsus, 0.56 mm. Second patella and tibia, 0.91 mm.; third, 0.56 mm.; fourth 0.83 mm. A male measured total length 1.7 mm. Carapace 0.90 mm. long, 0.72 mm. wide. First femur, 1.20 mm.; patella and tibia, 1.24 mm.; metatarsus, 0.94 mm.; tarsus, 0.45 mm. Second patella and tibia. 0.88 mm.; third, 0.52 mm.; fourth, 0.80 mm.

One male from Chiapas has scattered red spots on the abdomen.

Diagnosis. This species has the abdomen wider than long; it can be separated from *T. sexmaculatum* and *T. rufipunctum* by the genitalia (Figs. 227-229).

Records. Hidalgo: Chapulhuacán (W. J. Gertsch). *Puebla:* Villa Juárez (H. Wagner). *Chiapas:* Tenejapa (C. Goodnight): nr. Cacahuatán, 3000 m. (C. Goodnight). *Panama:* El Volcán, ♀ allotype, ♀, ♂ paratypes; El Valle; Boquete (all A. M. Chickering).

THERIDION RUFIPUNCTUM, new species
Figures 230-233

Type. Male type from El Volcán, Panama, Aug. 9-14, 1950 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace with one or two small median black spots. Sternum white. Legs white with a small black spot prolateral on patellae and on distal ends of tibiae. Abdomen white, dorsum and sides with red spots (Fig. 230). Anterior median eyes one and one-half diameters apart, one from laterals. Posterior median eyes one and one-half diameters apart, one from laterals in female; one and one-half in male. Total length of females 1.8-2.2 mm. One female measured total length 2.0 mm.; carapace 0.91 mm. long, 0.71 mm. wide. First femur, 1.43 mm.; patella and tibia, 1.30 mm.; metatarsus, 1.01 mm.; tarsus, 0.74 mm. Second patella and tibia, 1.01 mm.; third, 0.59 mm.; fourth, 0.92 mm. Male measured total length, 2.0 mm. Carapace 0.91 mm. long, 0.75 mm. wide. First femur, 1.20 mm.; patella and tibia, 1.47 mm.; metatarsus, 1.00 mm.; tarsus, 0.50 mm. Second patella and tibia, 1.03 mm.; third, 0.65 mm.; fourth, 0.92 mm.

Diagnosis. The spotted abdomen (Fig. 230), which is wider than long in the female, and the genitalia (Figs. 231, 233) distinguish this species from *T. sexmaculatum.*

Records. Panama: El Volcán, ♀ allotype, paratypes (A. M. Chickering; W. J. Gertsch); Boquete (A. M. Chickering).

THERIDION NADLERI, new species
Figures 240-241

Type. Female type from Simla, near Arima, Trinidad, Dec. 28, 1954 (A. M. Nadler), in the American Museum of Natural History.

Description. Spider yellow-white in coloration except dorsum of abdomen which has some pigment spots. Diameter of anterior median eyes one and one-half times that of other eyes. Anterior median eyes their diameter apart, almost touching laterals. Posterior median eyes one and one-half diameters apart, two-thirds from laterals. Abdomen wider than long. Total length of female 1.9 mm. Carapace 0.75 mm. long, 0.65 mm. wide. First femur, 1.20 mm.; patella and tibia, 1.20 mm.; metatarsus, 0.81 mm.; tarsus, 0.43 mm. Second patella and tibia, 0.91 mm.; third, 0.65 mm.; fourth, 0.83 mm.

Diagnosis. The large opening of the epigynum (Fig. 241) differentiates this species from others.

THERIDION SEXMACULATUM Keyserling
Figures 236-239

Theridion sexmaculatum Keyserling, 1884, Die Spinnen Amerikas, vol. 1, no. 1, p. 82, pl. 4, fig. 51, ♀ (♀ syntypes from Amazonas Province, Brazil, in the Hope Department of Entomology, Oxford University); 1886, *ibid.*, vol. 2, p. 238, pl. 20, fig. 292, ♂.

Steatoda sexmaculata, F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 386, pl. 36, fig. 22, ♀.

Diagnosis. Color yellow-white except for three pairs of black spots on abdomen (Fig. 238); the spots which are only rarely absent and the genitalia (Figs. 237, 239) distinguish this small species.

Records. Guatemala. Canal Zone: Barro Colorado Isl.; Summit; Experimental Gardens; Forest Reserve (all A. M. Chickering); El Volcán (W. J. Gertsch). *Venezuela:* Rancho Grande (A. M. Nadler).

THERIDION DOTANUM (Banks), new combination
Figures 245-248

Singa dotana Banks, 1913, Proc. Acad. Nat. Sci. Philadelphia, vol. 65, p. 679, pl. 28, fig. 1 (♀ type from St. Maria Dota, Costa Rica, in the Museum of Comparative Zoology).

Description. Carapace, sternum, legs yellow-white. Legs with small black spots on distal ends of segments. Abdomen wider than long (Fig. 247) covered by white pigment and a black spot on each side; that of male narrower and darker. Eyes without black rings. Anterior median eyes more than a diameter apart, one-third of a diameter from laterals. Posterior eyes a third of a diameter apart. Anterior median eyes slightly smaller than others. Total length of female 2.5 mm. Carapace 0.94 mm. long, 1.11 mm. wide. First femur, 1.89 mm.; patella and tibia, 1.92 mm.; metatarsus, 1.40 mm.; tarsus, 0.62 mm. Second patella and tibia, 1.56 mm.; third, 1.04 mm.; fourth, 1.30 mm. Total length of male 2.0 mm. Carapace 0.98 mm. long, 0.92 mm. wide. First femur, 2.14 mm.; patella and tibia, 2.14 mm.; metatarsus, 1.50 mm.; tarsus, 0.57 mm. Second patella and tibia, 1.70 mm.; third, 0.92 mm.; fourth, 1.17 mm.

Diagnosis. The shape of the abdomen, the epigynum having a large bordered depression (Fig. 246) and the palpus (Fig. 248) distinguish this species from *T. sexmaculatum*.

Record. Oaxaca: Oaxaca (B. Malkin). *Panama:* El Volcán (A. M. Chickering, W. J. Gertsch).

THERIDION PALLISTERORUM, new species
Figures 242-244

Type. Male type from Contreras, Distrito Federal, 8-9000 ft., May 30, 1946 (C. J. and D. L. Pallister), in the American Museum of Natural History.

Description. Carapace yellow with a narrow black median line and black border. Legs yellow, femora brown to black, other segments with some black spots underneath. Abdomen white, sprinkled with black on dorsum, a white spot on the widest point on each side; venter with a median black spot. Anterior median eyes almost their diameter apart, one-third from laterals. Posterior median eyes almost their diameter apart, slightly more than a diameter from laterals. Total length of male 2.4 mm. Carapace, 1.1 mm. long, 1.1 mm. wide. First femur, 2.9 mm.; patella and tibia, 2.7 mm.; metatarsus, 1.8 mm.; tarsus, 0.7 mm. Second patella and tibia, 2.2 mm.; third, 1.0 mm.; fourth, 1.3 mm.

A female, which was slightly larger than the male, was in too poor condition for measurements.

Diagnosis. Only details of the palpus (Fig. 244) separate this species from *T. dotanum.* It is possible that this belongs to a northern form of the latter species.

Record. Distrito Federal: Santa Rosa, 2700 m., July 13, 1946, ♀ (H. Wagner).

THERIDION MINUTISSIMUM Keyserling
Figure 249

Theridion minutissimum Keyserling, 1884, Die Spinnen Amerikas, vol. 2, no. 1, p. 34, fig. 17, ♂, ♀, (♂ Lectotype here designated from Montana di Nancho, Peru, in the Polish Academy of Sciences, Warsaw.)

Description. Carapace, sternum orange. Most leg segments orange-white; first and second tibiae dark gray except for ends. All metatarsi dark gray. Abdomen black except for a broad horseshoe-shaped white band which encircles sides and anterior of dorsum, a white spot above spinnerets and four small white spots in center of dorsum. Anterior median eyes slightly larger than others, three-quarters diameter apart, almost touching laterals. Posterior eyes one-third diameter apart. Total length of male 1.2 mm. Carapace 0.71 mm. long, 0.52 mm. wide. First femur, 0.91 mm.; patella and tibia, 0.96 mm.; metatarsus, 0.60 mm.; tarsus, 0.28 mm. Second patella and tibia, 0.74 mm.; third, 0.45 mm.; fourth, 0.57 mm. The type of this species was examined.

Record. Panama Canal Zone: Experimental Gardens, Aug. 12-19, 1954 (A. M. Chickering).

THERIDION BARROANUM, new species
Figures 234-235

Type. Female type from Barro Colorado Island, June 1950 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, sternum, legs, abdomen yellow-white. Abdomen wider than long covered by white pigment on sides of dorsum and sides, but not in center of dorsum. Anterior median eyes one diameter apart, one-fourth from laterals. Posterior median eyes their radius apart, their diameter from laterals. Total length, 1.9 mm. Carapace 0.89 mm. long, 0.82 mm. wide. First femur, 1.10 mm.; patella and tibia, 1.10 mm.; metatarsus, 0.78 mm.; tarsus, 0.45 mm. Second patella and tibia, 0.98 mm.; third, 0.70 mm.; fourth, 0.85 mm.

Diagnosis. This species can be distinguished from other species, with an abdomen wider than long, by the position of the connecting ducts (Figs. 234, 235).

THERIDION CHIRIQUI, new species
Figures 268-271

Type. Male type from El Volcán, Panama, Feb. 26, 1936 (W. J. Gertsch), in the American Museum of Natural History.

Description. Yellow-white except for white dorsum of abdomen which is wider than long. Venter of abdomen anterior to pedicel dusky. In male, white pigment band across abdomen (Fig. 269). Anterior median eyes their diameter apart, less than one-fourth from laterals. Posterior median eyes two-thirds diameter apart, less than one-fourth in female, one radius in male from laterals. Total length of female 1.3 mm. Carapace, 0.65 mm. long, 0.55 mm. wide. First femur, 1.10 mm.; patella and tibia, 1.04 mm.; metatarsus, 0.80 mm.; tarsus, 0.39 mm.

Second patella and tibia, 0.78 mm.; third, 0.52 mm.; fourth, 0.79 mm. Total length of male 1.2 mm. Carapace, 0.61 mm. long, 0.55 mm. wide. First femur, 1.10 mm.; patella and tibia, 1.24 mm.; metatarsus, 0.83 mm.; tarsus, 0.42 mm. Second patella and tibia, 0.78 mm.; third, 0.50 mm.; fourth, 0.72 mm.

Diagnosis. Only the structure of the genitalia (Figs. 268, 271) distinguishes this species from *T. nudum* and others whose abdomen is wider than long. The posterior median eyes of the female almost touch the laterals.

Record. Panama: El Volcán, ♀, ♂ paratypes (W. J. Gertsch).

THERIDION PANAMENSE, new species
Figures 263-267

Type. Male type from El Volcán, Aug. 9-14, 1950 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace dark dusky yellow with a dark border. Sternum dark dusky. Legs yellow with irregular black patches and stripes. Dorsum of abdomen with a median dorsal white stripe, on sides black: sides of abdomen whitish, venter as illustrated (Fig. 267). Anterior median eyes one diameter apart, one-fourth diameter from laterals. Posterior eyes one diameter apart. Anterior median eyes sometimes slightly larger than others. Abdomen usually wider than long in female, not in male. Total length of females 1.6-2.5 mm. Female allotype measured total length 1.8 mm. Carapace 0.81 mm. long, 0.78 mm. wide. First femur, 1.36 mm.; patella and tibia, 1.51 mm.; metatarsus, 1.14 mm.; tarsus, 0.52 mm. Second patella and tibia, 1.05 mm.; third, 0.64 mm.; fourth, 0.98 mm. Total length of males 1.6-1.8 mm. Male type measured total length 1.6 mm. Carapace 0.88 mm. long, 0.78 mm. wide. First femur, 1.58 mm.; patella and tibia, 1.75 mm.; metatarsus, 1.48 mm.; tarsus, 0.52 mm. Second patella and tibia, 1.25 mm.; third, 0.71 mm.; fourth, 0.95 mm.

Diagnosis. The dark coloration, wider abdomen and epigynum with an anterior lip (Fig. 264), and the palpus, of the male (Figs. 265, 266) distinguish this from *Theridion atropunctatum.*

Records. Panama: Boquete (many specimens); El Valle; ♀ allotype, ♂ paratypes (all A. M. Chickering); El Volcán (A. M. Chickering; W. J. Gertsch).

THERIDION ARTUM, new species
Figures 313-314

Type. Female type from Forest Preserve, Panama Canal Zone, Jan. 1958 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace dusky black, lighter in center, reddish around eyes. Sternum black. Legs yellowish with black rings on distal ends of femora, tibiae, metatarsi and irregular black spots on venter of segments. Abdomen with a median dorsal gray band, bordered by white, a white area anterior and posterior of the band. Venter black with tongues of black extending to the sides and a pair up the posterior. A pair of white spots between genital groove and spinnerets. Anterior median eyes slightly larger than others, their diameter apart and almost touching laterals. Posterior eyes their diameter apart. Total length 2.2 mm. Carapace 0.98 mm. long, 0.85 mm. wide. First femur, 1.92 mm.; patella and tibia, 1.96 mm.; metatarsus, 1.50 mm.; tarsus, 0.63 mm. Second patella and tibia, 1.22 mm.; third, 0.73 mm.; fourth, 1.23 mm.

Diagnosis. The epigynum (Fig. 314) which is a light area in a heavily pigmented region separates this species from *Theridion akron.* The openings are difficult to discern.

THERIDION AKRON, new species
Figures 250-252

Type. Male type from Summit, Panama Canal Zone, Aug. 1950 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace dusky yellow, sternum dusky. Legs yellowish; ends of segments dusky, with dusky patches on venter. Dorsum of abdomen with a median black band on spotted white background; continuation of band white in color anterior and posterior; sides of anterior and posterior portion of dorsum darker. Venter black with a pair of white spots. Anterior median eyes slightly larger than others, one diameter apart, almost touching laterals. Posterior median eyes their radius apart, three-quarters their diameter from laterals. Total length of female 2.0 mm. Carapace 0.78 mm. long, 0.66 mm. wide. First femur, 1.50 mm.; patella and tibia, 1.60 mm.; metatarsus, 1.17

mm.; tarsus, 0.49 mm. Second patella and tibia, 0.95 mm.; third, 0.92 mm. Total length of male 1.7 mm. Carapace 0.84 mm. long, 0.71 mm. wide. First femur, 1.67 mm.; patella and tibia, 1.68 mm.; metatarsus, 1.32 mm.; tarsus, 0.53 mm. Second patella and tibia, 1.10 mm.; third, 0.66 mm.; fourth, 0.99 mm.

Diagnosis. The palpus (Fig. 252) resembles that of *Dipoena* or *Achaearanea;* it has, however, a radix hidden behind the conductor, and the duct does not traverse the median apophysis as it does in *Dipoena.* The epigynal depression (Fig. 251) may have been covered with material in the specimens examined. The genitalia differentiate this species from *T. panamense.*

Records. Canal Zone: Barro Colorado Island, 2♀ (A. M. Chickering).

THERIDION RESUM, new species
Figures 253-254

Type. Female holotype from Forest Reserve, Panama Canal Zone, Aug. 10-12, 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, sternum, legs dusky yellow. Legs with faint indications of rings or spots on venter. Dorsum of abdomen spotted white with a darker median band; venter black with a pair of white spots and a white spot anterior to pedicel, a white line above spinnerets which continues into the dark dorsal band. Anterior median eyes slightly larger than others, their diameter apart, almost touching laterals. Posterior eyes less than a diameter apart. Abdomen as wide as long. Total length of female 2.0 mm. Carapace 0.78 mm. long, 0.73 mm. wide. First femur, 1.42 mm.; patella and tibia, 1.45 mm.; metatarsus, 1.08 mm.; tarsus, 0.52 mm. Second patella and tibia, 0.98 mm.; third, 0.62 mm.; fourth, 0.99 mm.

Diagnosis. The epigynum which has a median depression with a posterior sclerotized rim (Fig. 254) distinguishes this species from *T. panamense.* The latter species has one ventral white spot; *T. resum* has two.

THERIDION AKME, new species
Figures 210-211

Type. Female type from Summit Park, Panama Canal Zone, Dec. 1957 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, sternum yellowish. Legs golden yellow. Abdomen yellow-white. Anterior median eyes slightly larger than others, two-thirds their diameter apart, one-fourth their diameter from laterals. Posterior median eyes less than their diameter apart, two-thirds their diameter from laterals. Legs short. Abdomen widest slightly behind middle. Total length 2.7 mm. Carapace 0.98 mm. long, 0.94 mm. wide. First femur, 1.43 mm.; patella and tibia, 1.30 mm.; metatarsus, 1.00 mm.; tarsus, 0.55 mm. Second patella and tibia, 0.98 mm.; third, 0.75 mm.; fourth, 1.14 mm.

Diagnosis. The epigynum (Fig. 211) and internal genitalia distinguish this species.

THE THERIDION MOCTEZUMA GROUP

THERIDION RESERVUM, new species

Figures 318-321

Type. Male type from Forest Reserve, Canal Zone, July 4-6, 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, legs yellowish. First and second femora of female with two black lines on venter, and black rings around tibia-metatarsal joint. Abdomen yellow-white with two dorsal white lines and series of black spots (Fig. 320). Anterior median eyes one diameter apart, one-fourth from laterals. Posterior medians separated by two-thirds diameter in female, by one diameter in male. Total length of female 1.9 mm. Carapace 0.68 mm. long, 0.65 mm. wide. First femur, 1.03 mm.; patella and tibia, 0.96 mm.; metatarsus, 0.80 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.78 mm.; third, 0.52 mm.; fourth, 0.80 mm. Total length of male, 1.7 mm. Carapace 0.78 mm. long, 0.62 mm. wide. First femur, 1.42 mm.; patella and tibia, 1.55 mm.; metatarsus, 1.36 mm.; tarsus, 0.45 mm. Second patella and tibia, 1.00 mm.; third, 0.62 mm.; fourth, 0.95 mm.

Diagnosis. The striking coloration of this species as well as details of the genitalia (Figs. 319, 321) distinguish it from other species of *Theridion.*

Record. Canal Zone: Barro Colorado Isl. (several records). Forest Reserve, ♀, ♂ paratypes; Madden Dam (all A. M. Chickering).

THERIDION LATHROPI, new species
Figures 272-276

Type. Male type from Lathrop Trail, Barro Colorado Island, Canal Zone, July 6, 1954 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, legs dusky yellow. Sternum dusky. Abdomen black with a median longitudinal white stripe on dorsum which is widest in middle, narrower at ends; white patches on sides and a white spot behind genital groove on venter. Anterior median eyes three-quarters diameter apart, one-quarter from laterals. Posterior median eyes one-third diameter apart, three-quarters from laterals. Total length of females 1.8-2.2 mm. A female measured total length 1.8 mm. Carapace 0.83 mm. long, 0.75 mm. wide. First femur, 1.06 mm.; patella and tibia, 1.12 mm.; metatarsus, 0.78 mm.; tarsus, 0.41 mm. Second patella and tibia, 0.81 mm.; third 0.61 mm.; fourth, 0.91 mm. Total length of males 1.6-1.8 mm. A male measured total length 1.6 mm. Carapace 0.82 mm. long, 0.73 mm. wide. First femur, 1.17 mm.; patella and tibia, 1.35 mm.; metatarsus, 1.04 mm.; tarsus, 0.45 mm. Second patella and tibia, 1.00 mm.; third, 0.65 mm.; fourth, 0.92 mm.

Diagnosis. The palpus (Figs. 275-276) and the epigynum which has a projecting flat hook (Fig. 274) distinguish this species.

Records. Panama: Porto Bello (A. M. Chickering). *Canal Zone:* Barro Colorado Isl. (common); Forest Reserve; Ft. Davis (A. M. Chickering).

THERIDION PETRUM, new species
Figures 280-284

Type. Male type from Barro Colorado Island, Canal Zone, Panama, Aug. 14, 1954 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, sternum, legs dusky yellow. Abdomen black with white lines on dorsum (Fig. 283) and a white spot on venter between spinnerets and genital groove. Diameter of anterior median eyes one and one-half that of other eyes. Anterior median eyes one-half their diameter apart, one-third from laterals. Posterior medians two-thirds their diameter apart, one-half from laterals. Total length of female 1.2 mm. Carapace 0.62 mm. long, 0.55 mm. wide. First femur, 0.65 mm.; patella and tibia, 0.65 mm.; metatarsus, 0.42 mm.; tarsus, 0.31 mm. Second patella and tibia, 0.53 mm.; third, 0.43 mm.; fourth, 0.55 mm. Total length of male 1.3 mm. Carapace 0.62 mm. long; 0.53 mm. wide. First femur, 0.68 mm.; patella and tibia, 0.73 mm.; metatarsus, 0.50 mm.; tarsus, 0.34 mm. Second patella and tibia, 0.57 mm.; third, 0.44 mm.; fourth, 0.60 mm.

Diagnosis. The palpus (Fig. 284) differentiates the male from *T. marvum.* The epigynum has a knob (Figs. 281, 282) resembling that of *T. neomexicanum;* however, coloration and leg length differentiate the two species.

Records. Canal Zone: Barro Colorado Isl., ♂, ♀ paratypes (sev. collections). *Lesser Antilles:* Trinidad: Piarco (A. M. Nadler).

THERIDION MARVUM, new species
Figure 326

Type. Male type from Barro Colorado Island, Panama Canal Zone, July 30, 31, 1936 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, sternum, legs dusky yellow. Abdomen gray with white lines on dorsum similar to *T. petrum* (Fig. 283); venter with a white spot anterior to spinnerets. Anterior median eyes two-thirds their diameter apart, one-third from laterals. Posterior medians two-thirds their diameter apart, one-half their diameter from laterals. Total length of male 1.3 mm. Carapace 0.71 mm. long, 0.55 mm. wide. First femur, 0.91 mm.; patella and tibia, 0.99 mm.; metatarsus, 0.67 mm.; tarsus, 0.39 mm. Second patella and tibia, 0.78 mm.; third, 0.53 mm.; fourth, 0.67 mm.

Diagnosis. Lighter coloration, slightly larger size, smaller anterior median eyes and the structure of the palpus (Fig. 326) separate this species from *T. petrum.*

Records. Canal Zone: Barro Colorado Island, ♂ paratypes (A. M. Chickering); Boquete (A. M. Chickering).

THERIDION MOCTEZUMA, new species
Figures 285-288

Type. Male type from La Planta de Moctezuma, near Fortín, Veracruz, July 7, 1947 (C. and M. Goodnight), in the American Museum of Natural History.

Description. Carapace, sternum, legs, dusky yellow-brown. Abdomen black with a white median dorsal band (Fig. 287), several lateral spots and a white spot on venter behind genital groove. Anterior median eyes one diameter apart, one-third from laterals. Posterior median eyes their radius apart, two-thirds from laterals. Abdomen of male with posterior muscle impressions sclerotized. Total length of female 2.5 mm. Carapace 1.04 mm. long, 0.93 mm. wide. First femur, 1.43 mm.; patella and tibia, 1.60 mm.; metatarsus, 1.20 mm.; tarsus, 0.58 mm. Second patella and tibia, 1.15 mm.; third, 0.91 mm.; fourth, 1.30 mm. Total length of male 2.3 mm. Carapace 1.04 mm. long, 0.88 mm. wide. First femur, 1.50 mm.; patella and tibia, 1.80 mm.; metatarsus, 1.40 mm.; tarsus, 0.63 mm. Second patella and tibia, 1.30 mm.; third, 0.98 mm.; fourth, 1.30 mm.

Diagnosis. The epigynum which has a translucent projecting knob (Fig. 286) and the palpus can be used to separate this species from *T. lathropi.*

Records. Veracruz: La Buena Ventura, 1909 (A. Petrunkevitch).

THERIDION COBANUM, new species
Figures 291-292

Type. Female holotype from Cobán, Guatemala, July 1947 (C. and P. Vaurie), in the American Museum of Natural History.

Description. Carapace yellow-brown with a median dusky line. Sternum, legs yellow-brown; legs with faint indications of darker rings. Dorsum of abdomen with two rows of large black spots, their diameter apart; almost no white pigment present; venter dusky. Anterior median eyes their diameter apart, one-third their diameter from laterals. Posterior eyes two-thirds diameter apart. Total length of female, 2.5 mm. Carapace, 1.30 mm. long, 1.04 mm. wide. First femur, 1.80 mm.; patella and tibia, 1.93 mm.; metatarsus, 1.46 mm.; tarsus, 0.69 mm. Second patella and tibia, 1.48 mm.; third, 1.06 mm.; fourth, 1.61 mm.

Diagnosis. The epigynum (Fig. 292) distinguishes this species from *T. moctezuma.*

Record. Tabasco: Teapa (C. and M. Goodnight).

THERIDION ASPERSUM (F. P. Cambridge)

Figures 311-312

Steatoda aspersa F. P. Cambridge, 1902, Biologia Centrali Americana, Araneidea, vol. 2, p. 384, pl. 36, fig. 13, ♀ (♀ type from Guatemala, in the British Museum, Natural History).

Theridion aspersum, Roewer, 1942, Katalog der Araneae, vol. 1, p. 490.

THERIDION QUANTUM, new species

Figures 293-294, 317

Type. Male type from Summit, Canal Zone, July 21-29, 1950 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace yellowish with a median dusky line and dusky sides. Sternum dusky. Legs yellowish with indistinct dusky rings. Abdomen black with a white dorsal stripe, which is narrower at both ends; some white spots on sides; venter black. Anterior median eyes one diameter apart, a radius from laterals. Posterior median eyes of female less than one diameter apart, two-thirds from laterals. Anterior median eyes of males slightly smaller than others. Posterior medians of male two-thirds diameter apart, one from laterals. Total length of female 2.2 mm. Carapace 0.91 mm. long, 0.78 mm. wide. First femur, 1.15 mm.; patella and tibia, 1.15 mm.; metatarsus, 0.91 mm.; tarsus, 0.49 mm. Second patella and tibia, 0.96 mm.; third, 0.71 mm.; fourth, 1.04 mm. Total length of male 1.6 mm. Carapace 0.78 mm. long, 0.68 mm. wide. First femur, 1.15 mm.; patella and tibia, 1.25 mm.; metatarsus, 0.98 mm.; tarsus, 0.50 mm. Second patella and tibia, 0.92 mm.; third, 0.62 mm.; fourth, 0.87 mm.

Diagnosis. The epigynum has a pair of light areas divided by a small lobe (Fig. 294); the palpus has a conductor of distinctive shape (Fig. 317).

Records. Costa Rica: Orosi (Picado); San José (E. Schmidt). *Canal Zone:* Summit, ♀ paratypes; Forest Reserve; Experimental Gardens (A. M. Chickering).

THERIDION MALKINI, new species
Figures 295-296

Type. Female type from Tamazunchale, San Luis Potosí, June 26, 1947 (B. Malkin), in the American Museum of Natural History.

Description. Carapace dusky yellow, duskier on sides. Sternum dusky yellow. Legs yellow with faint dusky rings and dusky femora. Abdomen with a median dorsal white band whose edges are scalloped and which narrows towards the spinnerets; sides with some white spots. Anterior median eyes two-thirds diameter apart, one-quarter from laterals. Posterior median eyes their radius apart, two-thirds diameter from laterals. Total length of female 2.0 mm. Carapace 0.97 mm. long, 0.91 mm. wide. First femur, 1.24 mm.; patella and tibia, 1.40 mm.; metatarsus, 1.01 mm.; tarsus, 0.52 mm. Second patella and tibia, 1.04 mm.; third, 0.78 mm.; fourth, 1.17 mm.

Diagnosis. The epigynum whose openings are anterior (Fig. 296) distinguishes this species from *T. quantum*.

THERIDION RUINUM, new species
Figure 325

Type. Male type from Las Ruinas de Palenque, Chiapas, July 14, 1949 (C. J. Goodnight), in the American Museum of Natural History.

Description. Carapace yellow with a median dusky stripe and dusky sides. Sides of sternum dusky. Legs dusky yellow. Abdomen black with a median dorsal white stripe having scalloped edges; venter without much pigment. Eyes large. Anterior medians three-quarters diameter apart, almost touching laterals. Posterior medians one-third diameter apart, one-half from laterals. Total length of male, 1.5 mm. Carapace 0.67 mm. long, 0.62 mm. wide. First femur, 1.00 mm.; patella and tibia, 1.04 mm.; metatarsus, 0.87 mm.; tarsus, 0.42 mm. Second patella and tibia, 0.85 mm.; third 0.62 mm.; fourth, 0.85 mm.

Diagnosis. Details of the palpus (Fig. 325) separate this species from *T. quantum*.

THERIDION SIGNUM, new species
Figures 297-298, 332

Type. Male type from Boquete, Panama, July 10-25, 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace dusky yellow-brown. Sternum dusky yellow. Legs yellow-brown with indistinct dusky bands on middle and ends of segments. Abdomen mottled white on black with a median dorsal white band and a series of five white spots on sides; venter with an indistinct spot behind epigastric furrow. Anterior median eyes one diameter apart less than one-fourth from laterals. Posterior medians their radius apart, less than a diameter from laterals. A female measured total length 2.2 mm. Carapace 1.0 mm. long, 0.89 mm. wide. First femur 1.33 mm.; patella and tibia, 1.44 mm.; metatarsus, 1.05 mm.; tarsus, 0.55 mm. Second patella and tibia, 1.10 mm.; third, 0.78 mm.; fourth, 1.18 mm. A male measured total length, 1.9 mm. Carapace 0.88 mm. long, 0.78 mm. wide. First femur, 1.28 mm.; patella and tibia, 1.43 mm.; metatarsus, 1.01 mm.; tarsus, 0.51 mm. Second patella and tibia, 1.10 mm.; third, 0.75 mm.; fourth, 1.01 mm.

This species is distinguished by the following characters:

Diagnosis. The epigynum has a small hookshaped projection (Fig. 298); the palpus has the radix enlarged, covering the conductor on the ventral side by a transparent lobe, wrapped all around the back of the bulb and terminating in a large flat projection. Embolus is small and hidden by conductor and radix (Fig. 332).

Records. Panama: Boquete, ♀ allotype July 10-25, 1939; ♀ paratype Aug. 4-11, 1954 (A. M. Chickering).

THERIDION CHILAPA, new species
Figures 309-310

Type. Female type from Chilapa, Guerrero, Mexico, Oct. 29, 1934 (L. Schultze), in the American Museum of Natural History.

Description. Carapace yellow-brown. Legs yellow-brown with some dusky rings on middle and ends of distal segments. Abdomen black with a median dorsal black band bordered by a wavy white line. Some light patches on sides. Eyes subequal in size. Anterior median eyes one diameter apart, two-thirds diameter from laterals. Posterior median eyes two-thirds diameter apart, a little more than one from laterals. Total length 2.5 mm. Carapace, 1.1 mm. long, 1.1 mm. wide. Second patella and tibia, 1.1 mm.; third, 0.9 mm.; fourth, 1.3 mm.

Diagnosis. The epigynum having openings in a pair of nipples facing each other and a median depression (Fig. 310) separate this species from *Theridion paidiscum.*

THERIDION SCHMIDTI, new species
Figure 331

Type. Male type from San José, Costa Rica (E. Schmidt), in the American Museum of Natural History.

Description. Carapace, sternum, legs yellow. Abdomen gray with a median dorsal white band whose borders are irregular. Anterior median eyes one diameter apart, less than one-fourth from laterals. Posterior median eyes their radius apart, almost their diameter from laterals. Total length of male 1.9 mm. Carapace 0.80 mm. long, 0.63 mm. wide. First femur, 1.22 mm.; patella and tibia, 1.35 mm.; metatarsus, 1.08 mm.; tarsus, 0.53 mm. Second patella and tibia, 1.03 mm.; third, 0.74 mm.; fourth, 0.93 mm.

Diagnosis. Details of the palpus (Fig. 331) separate this species from *T. quantum.*

THERIDION PAIDISCUM, new species
Figures 299-300, 329-330

Type. Male type from Boquete, Panama, Aug. 4-11, 1954 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, sternum, dark dusky yellow. Legs yellow with dark dusky rings on middle and ends of segments. Abdomen mottled black with a median dorsal, white stripe, whose borders are irregular; several white spots on sides; venter without marks. Anterior median eyes one diameter apart, almost touching laterals. Posterior eyes three-quarters diameter apart. Measurement of female total length, 2.3 mm. Carapace, 1.04 mm. long, 1.00 mm. wide. First femur, 1.32 mm.; patella and tibia, 1.46 mm.; metatarsus, 1.03 mm.; tarsus, 0.57 mm. Second patella and tibia, 1.12 mm.; third, 0.85 mm.; fourth, 1.18

mm. Male total length 1.7 mm. Carapace 0.91 mm. long, 0.78 mm. wide. First femur, 1.10 mm.; patella and tibia, 1.30 mm.; metatarsus, 0.78 mm.; tarsus, 0.52 mm. Second patella and tibia, 1.00 mm.; third, 0.73 mm.; fourth, 0.98 mm.

Diagnosis. The epigynum (Fig. 300) has a pair of small sclerotized protuberances along the margin and a median small protuberance which distinguishes it from *T. signaculum.* The palpus (Fig. 330) resembles that of *Sphyrotinus* species; the various sclerites have shifted to the back of the bulb and are reduced in size.

Record. Panama: Boquete, ♀ paratype (A. M. Chickering).

THERIDION SIGNACULUM, new species

Figures 301-302, 333

Type. Male type from Forest Reserve, Canal Zone, July 4-6, 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace dusky white to dusky brown. Sternum dusky. Legs white with faint indications of rings or dusky patches on venter. Abdomen dark with a median dorsal white stripe, which is narrow on ends and has wavy sides; venter black with a white spot posterior to genital groove. Anterior median eyes less than one diameter apart, one-fourth a diameter from laterals. Posterior eyes separated by less than one diameter. The anterior median eyes of the male are larger than the others and less than their radius apart. Total length of females 1.6-2.0 mm. A female paratype measured total length 1.8 mm. Carapace 0.75 mm. long, 0.68 mm. wide. First femur, 0.91 mm.; patella and tibia, 0.95 mm.; metatarsus, 0.65 mm.; tarsus, 0.39 mm. Second patella and tibia, 0.75 mm.; third, 0.56 mm.; fourth, 0.82 mm. Total length of male 1.6 mm. Carapace 0.71 mm. long, 0.62 mm. wide. First femur, 1.00 mm.; patella and tibia, 1.05 mm.; metatarsus, 0.75 mm.; tarsus, 0.42 mm. Second patella and tibia, 0.79 mm.; third, 0.60 mm.; fourth, 0.75 mm.

Diagnosis. The female has an epigynum similar to *T. paidiscum,* but it lacks the median protuberance (Fig. 302); the palpus of the male resembles *T. signum;* the radix, however, is smaller (Fig. 333).

Records. Panama: Porto Bello (A. M. Chickering). *Canal Zone:* Madden Dam; Barro Colorado Isl. (several collections); Forest Reserve, ♀, ♂ paratypes (all A. M. Chickering).

THERIDION ATLIXCO, new species

Figures 303-304

Type. Female type from Atlixco, Puebla, June 26, 1947 (L. I. Davis), in the American Museum of Natural History.

Description. Carapace dark gray, head region brown, reddish around eyes. Sternum black. Legs white with black spots or irregular narrow black rings. Abdomen with a median white band most distinct above spinnerets; and a white cross band on anterior half of dorsum. Venter with a black spot on each side of pedicel; a black ring around spinnerets; a wide black band from spinnerets to epigynum bearing a large white spot in center. Anterior median eyes one and one-quarter diameters apart, less than one-quarter from laterals. Posterior eyes two-thirds their diameter apart. Abdomen slightly wider than long, anterior end widest, subtriangular. Total length, 1.6 mm. Carapace 0.70 mm. long, 0.69 mm. wide. First femur, 0.91 mm.; patella and tibia, 0.99 mm.; metatarsus, 0.66 mm.; tarsus, 0.32 mm. Second patella and tibia, 0.68 mm.; third, 0.50 mm.; fourth, 0.75 mm.

Diagnosis. The indistinct epigynum (Fig. 304), covered by black pigment, differentiates this species from other Theridions.

THERIDION PROGUM, new species

Figures 305-306

Type. Female type from El Valle, Panama, July 1936 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, sternum, legs dusky yellow-brown. Legs with indistinct darker rings. Abdomen black with a white stripe above spinnerets and several spots on sides. Anterior median eyes two-thirds diameter apart, almost touching laterals. Posterior median eyes one-third diameter apart, a radius from laterals. Total length 2.4 mm. Carapace 1.00 mm. long, 0.88 mm. wide. First femur, 1.32 mm.; patella and tibia, 1.40 mm.; metatarsus, 1.04 mm.; tarsus, 0.55 mm. Second patella and tibia, 1.04 mm.; third, 0.80 mm.; fourth, 1.15 mm.

Diagnosis. The openings of the ducts are on the ends of a swollen area on the epigynum (Fig. 306). The swollen area separates this species from *T. signaculum.*

THERIDION COLIMA, new species

Figures 277-279

Type. Female type from Miramar, Manzanillo, Colima, Jan. 15, 1943 (F. Bonet), in the American Museum of Natural History.

Description. Carapace, sternum, legs yellow. Legs dusky at joint of femur and patella. Abdomen whitish with a small dusky spot on dorsum and a dusky ring around spinnerets. Anterior median eyes one diameter apart, one-third of a diameter from laterals. Posterior median eyes one diameter apart, a radius from laterals. Total length of female 1.8 mm. Carapace 0.78 mm. long, 0.70 mm. wide. First femur, 1.14 mm.; patella and tibia, 1.12 mm.; metatarsus, 0.92 mm.; tarsus, 0.53 mm. Second patella and tibia, 0.78 mm.; third, 0.52 mm.; fourth, 0.88 mm.

The generic placement of this species is not certain. It is possible that it belongs to the genus *Achaearanea.*

Diagnosis. The epigynum has a slight median elevation on whose sides are openings (Figs. 278, 279). This distinguishes the species from other theridiids known.

THERIDION CLEMENS, new species

Figures 322-324

Type. Male type from Blue Mountains, 5-7000 ft.; Jamaica, British West Indies, Aug. 17-19, 1934 (P. J. Darlington), in the Museum of Comparative Zoology.

Description. Carapace, sternum, legs yellow. Abdomen with two dorsal longitudinal black bands, white in between and on sides; sometimes with series of black spots. Diameter of anterior median eyes half that of others. Anterior median eyes one and one-third diameters apart, two-thirds diameters from laterals. Posterior median eyes one diameter apart, one and one-quarter diameters from laterals. Chelicerae of female enlarged. Measurement of female 2.4 mm. total length. Carapace 0.83 mm. long, 0.78 mm. wide. First femur, 1.56 mm.; patella and tibia, 1.69

mm.; metatarsus, 1.30 mm.; tarsus, 0.57 mm. Second patella and tibia, 1.19 mm.; third, 0.78 mm.; fourth, 1.24 mm. Male 1.9 mm. total length. Carapace 0.85 mm. long, 0.60 mm. wide. First femur, 1.69 mm.; patella and tibia, 1.91 mm.; metatarsus, 1.56 mm.; tarsus, 0.60 mm. Second patella and tibia, 1.26 mm.; third, 0.78 mm.; fourth, 1.20 mm.

Diagnosis. The small anterior median eyes, the projecting median apophysis of the palpus (Fig. 324), and the structure of the epigynum (Fig. 323) distinguish this species from others.

Records. Jamaica: Blue Mts., 5-7000 ft., ♀ allotype, ♀, ♂ paratypes (P. J. Darlington); Hardwar Gap, Blue Mts. (many collections); N. Morces Gap, St. Andrew Par. (R. P. Bengry).

THERIDION TEMPUM, new species
Figures 315-316

Type. Female from the Forest Preserve, Panama Canal Zone, Dec. 24, 1957 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace dusky gray, darkest in eye region. Sternum dusky, lighter yellow in the middle. Endites and labium yellowish. Legs dusky gray. Abdomen yellow-gray with some white pigment spots on each side of dorsum, one black spot on each side of spinnerets. Eyes subequal in size. Anterior median eyes their diameter apart, almost touching laterals. Abdomen globular, as high as long. Posterior median eyes one diameter apart, two-thirds from laterals. Total length 2.3 mm. Carapace, 0.84 mm. long, 0.68 mm. wide. First femur, 1.04 mm.; patella and tibia, 1.04 mm.; metatarsus, 0.78 mm.; tarsus, 0.45 mm. Second patella and tibia, 0.74 mm.; third, 0.53 mm.; fourth, 0.79 mm.

Diagnosis. The epigynum having a slight central depression and the long connecting ducts (Fig. 315) separate this species from *Theridion plantatum.*

THERIDION PLANTATUM, new species
Figures 255-256

Type. Female holotype from Plantation, Barro Colorado Island, Panama Canal Zone, July 19, 1954 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace yellowish orange. Sternum orange. Legs yellow brown. Abdomen orange-white; posterior portion and area around spinnerets dusky; venter dusky. Anterior median eyes slightly larger than others, their diameter apart, one-quarter from laterals. Posterior eyes two-thirds diameter apart. Legs very strong. Total length of female 2.4 mm. Carapace 1.04 mm. long; 0.97 mm. wide. First femur, 1.56 mm.; patella and tibia, 1.35 mm.; metatarsus, 1.17 mm.; tarsus, 0.52 mm. Second patella and tibia, 1.04 mm.; third, 0.78 mm.; fourth, 1.24 mm.

Diagnosis. The unusual coloration, the epigynum and internal genitalia (Fig. 256) distinguish this species from others.

THERIDION ARMOURI, new species

Figures 259-260

Type. Female holotype from Armour Trail, Barro Colorado Island, Panama Canal Zone, July 17, 1954 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace orange-brown. Sternum orange. Legs dusky gray, distal segments darker. Abdomen dark gray above, reddish below. Anterior median eyes one diameter apart, almost touching laterals. Posterior eyes their diameter apart. Total length of female 2.0 mm. Carapace 0.71 mm. long. First femur, 0.88 mm.; patella and tibia, 0.98 mm.; metatarsus, 0.70 mm.; tarsus, 0.41 mm. Second patella and tibia, 0.71 mm.; third, 0.59 mm.; fourth, 0.85 mm.

The relatively high abdomen may indicate that this species belongs to *Achaearanea.*

Diagnosis. The epigynum (Fig. 260) has a depression. The internal genitalia (Fig. 259) distinguish this species from others with a similar epigynum.

THERIDION BRIDGESI, new species

Figures 307-308, 328

Type. Male holotype from Pujal, San Luis Potosí, outside cave, March 1940 (W. Bridges), in the American Museum of Natural History.

Description. Carapace yellowish with a median dusky band, sides dusky. Sternum dusky. Legs with dusky spots on ends of segments. Abdomen dusky black with a median dorsal white stripe whose edges are irregular. Sides with some white spots; venter with a white spot. Anterior median eyes two-thirds diameter apart, almost touching laterals; posterior eyes their radius apart. Total length of female 2.0 mm. Carapace 0.89 mm. long; 0.79 mm. wide. First femur, 1.30 mm.; patella and tibia, 1.37 mm.; metatarsus, 1.04 mm.; tarsus, 0.52 mm. Second patella and tibia, 1.12 mm.; third, 0.85 mm.; fourth, 1.17 mm. Total length of male 1.6 mm. Carapace 0.78 mm. long, 0.69 mm. wide.

Diagnosis. The epigynum which is heavily pigmented and has two dark spots on the anterior end of a lightly sclerotized plate (Fig. 308) and the palpus which bears a thorn (conductor) on the tegulum (Fig. 328) differentiates this species from others. A radix and median apophysis is present.

Records. San Luis Potosí: Pujal, ♀, ♂ paratypes (W. Bridges); Tamazunchale (W. J. Gertsch).

THERIDION MUSAWAS, new species
Figure 327

Type. Male type from Musawas, Río Waspuc, Nicaragua, Oct. 10-31, 1955 (B. Malkin), in the American Museum of Natural History.

Description. Carapace dusky yellow, darker in middle and near margins. Sternum, legs dusky yellow. Abdomen dark gray to black with indications of a median, dorsal white band. Anterior median eyes three-quarters diameter apart, less than one-quarter from laterals. Posterior median eyes one-third diameter apart, two-thirds from laterals. Posterior muscle scars on abdomen sclerotized. Total length of male 1.6 mm. Carapace, 0.80 mm. long, 0.58 mm. wide. First femur, 1.05 mm.; patella and tibia, 1.17 mm.; metatarsus, 0.78 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.88 mm.; third, 0.65 mm.; fourth, 0.88 mm.

Diagnosis. Details of the palpus (Fig. 327) separate this species from *T. bridgesi.*

THERIDION RINCONENSE, new species
Figures 261-262

Type. Female type from Rincón, Chiapas, April 6, 1953 (L. I. Davis), in the American Museum of Natural History.

Description. Carapace yellow, slightly dusky in center. Sternum, legs yellow. Legs with indications of bands on venter. Abdomen spotted black, with a white line above spinnerets; venter yellowish. Anterior median eyes their diameter apart, one-fourth from laterals. Posterior median eyes their radius apart, two-thirds from laterals. Total length of female 2.5 mm. Carapace 1.04 mm. long, 0.91 mm. wide. First femur, 1.42 mm.; patella and tibia, 1.56 mm.; metatarsus, 1.05 mm.; tarsus, 0.68 mm. Second patella and tibia, 1.17 mm., third, 0.89 mm.; fourth, 1.20 mm.

Diagnosis. The epigynum (Fig. 262) differentiates this species from other *Theridion.*

THERIDION PANUM, new species
Figures 289-290

Type. Female type from El Volcán. Chiriquí, Panama, March 7, 1936 (W. J. Gertsch), in the American Museum of Natural History.

Description. Carapace yellow with dusky head and a black line around margin. Legs yellow with indications of rings. Abdomen black with a median dorsal white band having scalloped edges and narrowing at the posterior; a white band around anterior edge; some white pigment on each side of pedicel on venter. Anterior median eyes slightly larger than others, their diameter apart, one-fourth their diameter from laterals. Posterior eyes one diameter apart. Total length of female 2.6 mm. Carapace 1.04 mm. long, 0.78 mm. wide. First femur, 1.87 mm.; patella and tibia, 2.05 mm.; metatarsus, 1.60 mm.; tarsus, 0.73 mm. Second patella and tibia, 1.42 mm.; third, 0.91 mm.; fourth, 1.46 mm.

Diagnosis. The structure of the very small epigynum (Fig. 290) separates this species from *T. moctezuma.*

THERIDION QUEMADUM, new species
Figures 257-258

Type. Female type from Cruz Quemada, 2000 m., nr. Amatenango, Chiapas, July 24, 1950 (C. and M. Goodnight), in the American Museum of Natural History.

Description. Carapace yellow, head dusky, border with a black line. Sternum dusky yellow. Legs yellow with ends of segments dusky. Abdomen black with lighter patches on sides of dorsum and a light stripe above spinnerets. Anterior median eyes slightly smaller than others, their diameter apart, one-fourth from laterals. Posterior eyes two-thirds diameter apart. Total length 2.9 mm. Carapace 1.15 mm. long, 1.04 mm. wide. First femur, 1.71 mm.; patella and tibia, 1.89 mm.; metatarsus, 1.41 mm.; tarsus, 0.65 mm. Second patella and tibia, 1.28 mm.; third, 0.94 mm.; fourth, 1.49 mm.

Diagnosis. The epigynum (Fig. 258) distinguishes this species from *T. morulum.*

SPHYROTINUS Simon

Sphyrotinus Simon, 1894, Proc. Zool. Soc. London, p. 524. Type species by monotypy: *S. luculentus* Simon.

Hypobares Simon, 1894, *op. cit.*, p. 552. Type species *H. unisignatus* Simon by original designation and monotypy.

Philto Simon, 1894, *op. cit.*, p. 552. Type species *P. subtilis* Simon by original designation and monotypy.

Hubba O. P. Cambridge, 1897, Biologia Centrali Americana, Araneidea, vol. 1, p. 231. Type species by monotypy *H. insignis* O. P. Cambridge.

Thonastica Simon, 1909, Bull. Biol. France et Belgique, vol. 42, p. 92. Type species *T. praemollis* Simon by original designation and monotypy.

Garricola Chamberlin, 1916, Bull. Mus. Comp. Zool., vol. 60, p. 233. Type species by original designation and monotypy *G. sanctus* Chamberlin.

Paidisca Bishop and Crosby, 1926, Jour. Elisha Mitchell Sci. Soc., vol. 41, p. 178. Type species by original designation and monotypy *Histagonia marxi* Crosby.

Spelobion Chamberlin and Ivie, 1938, Publ. Carnegie Inst. Washington, no. 491, p. 133. Type species by original designation and monotypy *S. spukilum* Chamberlin and Ivie (= *Sphyrotinus luculentus* Simon).

Thymoella Bryant, 1938, Bull. Mus. Comp. Zool., vol. 100, p. 377. Type species by original designation *T. banksi* Bryant.

Brontosauriella Bristowe, 1938, Ann. Mag. Nat. Hist., ser. 11, vol. 2, p. 72. Type species *B. melloleitaoni* Bristowe by monotypy.

The members of this genus appear similar. The cephalothorax with appendages are brown and the abdomen, which may have dusky marks, is whitish. The legs are shorter than those of *Theridion.* The carapace may be modified in males like that of erigonids, sometimes the first legs are enlarged. In the northern part of the region the species are often heavily sclerotized. Although a distinct group, this genus grades into *Theridion* and the placement of some species may be arbitrary. Both genera lack a colulus and have a relatively complicated palpus.

Judging by the collections examined, individual species may be extremely abundant locally and can be collected by the hundreds in litter or detritus. Only a few miles off, one or several other species may be found similarly abundant. Unfortunately the collections examined only rarely had detailed ecological notes.

Geographic variation of most species is so great that individual specimens from less explored areas are difficult to place, and it is often difficult to decide if a collection is a new species or a form of one previously described.

Paidisca simplex Bryant, 1940, Bull. Mus. Comp. Zool., vol. 86, p. 301, fig. 66, ♀ has a large colulus and is probably a linyphiid.

SPHYROTINUS LUCULENTUS Simon
Figures 334-338

Sphyrotinus luculentus Simon, 1894, Proc. Zool. Soc. London, p. 524. (♀, ♂ syntypes from St. Vincent Island, Lesser Antilles, in the British Museum, Natural History). Roewer, 1942, Katalog der Araneae, vol. 1, p. 459.

Theonoe americana Simon, 1897, *op. cit.*, p. 864. (♀ type from St. Vincent Isl., Lesser Antilles, in the British Museum, Natural History). NEW SYNONYMY.

?*Spelobion spukilum* Chamberlin and Ivie, 1938, Publ. Carnegie Inst. Washington, no. 491, p. 133, fig. 11, ♀ (♀ type from Spukil Cave, Calcehtoc, Yucatan, in the University of Utah collection).

Description. Diameter of anterior median eyes one-half that of others. Anterior median eyes almost one diameter apart. Posterior eyes separated by one-third their diameter. Abdomen with an indistinct dark line on dorsum. The specimens from St. Vincent Isl. examined lacked dark eye rings. The male has first femur swollen. Total length of female 1.2 mm. Carapace 0.53 mm. long, 0.49 mm. wide. First femur, 0.65 mm.; patella and tibia, 0.71 mm.; metatarsus, 0.42 mm.; tarsus, 0.29 mm. Second patella and tibia, 0.53 mm.; third, 0.39 mm.; fourth, 0.57 mm. Total length of male 1.0 mm. Carapace 0.59 mm. long, 0.52 mm. wide. First femur, 0.78 mm. (0.18 mm. wide); patella and tibia, 0.78 mm.; metatarsus, 0.45 mm.; tarsus, 0.23 mm. Second patella and tibia, 0.55 mm.; third, 0.39 mm.; fourth, 0.52 mm.

Comment. The epigynum (Fig. 335) is much like that of *S. guanicae;* however, the females are smaller. Several specimens from Panama are probably this species although they have black eye rings, the femur is less swollen, and there are details in the difficult-to-study palpus that differ. The abdomen of some specimens has a dusky V-shaped mark, two lines converging towards the spinnerets. Otherwise, females may be very difficult to separate from those of *S. guanicae.* The drawings of the epigynum and palpus (Fig. 336) were made from type specimens.

Records. Chiapas: Finca Cuauhtémoc, nr. Cacahoatán, 3000 ft., ♂ (C. and M. Goodnight). *Canal Zone:* Barro Colorado Island, ♀, ♂ (A. M. Chickering). *St. Vincent Isl.* (Simon, 1894).

SPHYROTINUS CHICKERINGI, new species
Figures 339-341

Type. Male holotype, from Barro Colorado Island, Canal Zone, Aug. 22, 1954 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Anterior median eyes slightly smaller than others, three-quarters diameter apart, their radius from laterals. Posterior median eyes about their radius apart, less than one diameter from laterals. Total length of females 1.3-1.5 mm. A female measured total length 1.3 mm. Carapace 0.62 mm. long, 0.59 mm. wide. First femur, 0.75 mm.; patella and tibia, 0.75 mm.; metatarsus, 0.43 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.55 mm.; third, 0.49 mm.; fourth, 0.67 mm. Total length of males 1.2-1.5 mm. A male measured total length 1.2 mm. Carapace 0.55 mm. long; 0.52 mm. wide. First femur, 0.83 mm.; patella and tibia, 0.81 mm.; metatarsus, 0.53 mm.; tarsus, 0.35 mm. Second patella and tibia 0.65 mm.; third, 0.50 mm.; fourth, 0.67 mm.

Diagnosis. The flask-shaped seminal receptacles, visible through the epigynum (Fig. 340), and the relatively indistinct palpus (Fig. 341) separate this species from all others in the genus.

Records. Canal Zone: Barro Colorado Island, ♀ allotype, ♀, ♂ paratypes (very many collections); Experimental Gardens; Chilibre; Forest Reserve; Corozal; Gamboa; across canal at Pedro Miguel; Madden Dam; 4 m. beyond Pedro Miguel; 3 mi. N. of Pedro Miguel; Summit; Frijoles; Madden Dam N. of Paraiso (all A. M. Chickering).

SPHYROTINUS GUANICAE (Petrunkevitch), new combination
Figures 345-349; Map 6

Theridion guanicae Petrunkevitch, 1930, Trans. Connecticut Acad. Sci., vol. 30, p. 208, figs. 57, 58, ♀ (2♀ syntypes from Guanica, Porto Rico, probably lost).

Map 6. Distribution of *Sphyrotinus guanicae* (Petrunkevitch).

Description. Abdomen gray with three darker gray dorsal stripes; a gray ring around spinnerets. Anterior median eyes less than their diameter apart, one-quarter their diameter from laterals. Posterior median eyes three-quarters diameter apart, their radius from laterals. Anterior median eyes slightly smaller than others. Total length of females 1.3-1.7 mm. Total length of one from Jamaica 1.3 mm. Carapace 0.60 mm. long, 0.53 mm. wide. First femur, 0.56 mm.; patella and tibia, 0.62 mm.; metatarsus, 0.37 mm.; tarsus, 0.34 mm. Second patella and tibia, 0.49 mm.; third, 0.44 mm.; fourth, 0.59 mm. Total length of a male from Jamaica 1.2 mm. Carapace 0.60 mm. long, 0.53 mm. wide. First femur, 0.62 mm.; patella and tibia, 0.61 mm.; metatarsus, 0.39 mm.; tarsus, 0.34 mm. Second patella and tibia, 0.56 mm.; third, 0.44 mm.; fourth, 0.61 mm. The seminal receptacles of the females may touch or be separated by a short distance.

Diagnosis. The females are slightly larger than those of the rare *S. luculentus,* and the connecting duct bends before entering the seminal receptacles (Figs. 345, 346). The loop of the duct in the palpus (Figs. 348, 349) separates the males from other species.

Natural History. Found in litter and under stones.

Distribution. Mexico and Greater Antilles, except Cuba.

Records. Tamaulipas: 2 mi. E. of Nuevo Morelos (L. I. Davis). *San Luis Potosí:* Ciudad del Maíz (C. J. Goodnight); Tamazunchale (F. Bonet). *Colima:* Potrero Grande (F. Bonet); Miramar, Manzanillo (F. Bonet). *Veracruz:* Tierra Blanca (C. and M. Goodnight). *Puebla:* Tehuacán (W. J. Gertsch, V. Roth). *Tabasco:* Teapa (C. and M. Goodnight). *Jamaica:* Very common in all parts of the island. *Dominican Republic:* Ciudad Trujillo (A. M. Nadler); Boca Chica (A. M. Nadler). *Puerto Rico:* Guanica, types (A. Petrunkevitch); Maricao Forest, 2500 ft. (P. J. Darlington); Mayagüez (A. M. Nadler); Río Piedras (A. M. Nadler); Cidra, Treasure Isl. (A. M. Nadler); Loiza (A. S. Mills). *Virgin Islands:* St. Croix (H. Beatty).

SPHYROTINUS ILLUDENS (Gertsch and Mulaik), new combination
Figures 342-344

Paidisca illudens, Levi, 1957, Bull. Amer. Mus. Nat. Hist., vol. 112, p. 110, figs. 396, 399, 414, 415, ♀, ♂, map 40.

The specimens from Central America differ from those from Texas in being slightly smaller (females: 1.2-1.4 mm.; males: 1.3 mm.) than northern specimens, and by details of the genitalia: the conductor is less distinct in the southern specimens, the course of the connecting ducts of the female differs, but they open near the posterior margin. All males have a groove along the clypeus, and the palpal duct differs from that of males of *S. guanicae.*

Comments. It is very doubtful that this is all one species. However, no names were given nor descriptions made (except for *S. verus* below), since it would be doubtful that the descriptions based on individual females of a probably highly variable species would be recognized again. This species or species group has to be studied again as soon as larger series are available from Mexico.

Records of doubtful females: Veracruz: Papantla, Oct. 12, 1947, 2 ♀, one with longer legs and slightly different connecting ducts than the other (H. Wagner). *Chiapas:* Palenque Ruins, July 12, 1949, 1 ♀ collected with Berlese funnel (C. J. Goodnight). *Costa Rica:* 1 ♀.

Records from Central America. (Genitalia illustrated by Figs. 342-344.) *Costa Rica:* San José (E. Schmidt). *Panama:* Arraiján (A. M. Chickering). *Canal Zone:* Balboa; Experimental Gardens (many collections); Summit; across canal from Pedro Miguel; 3 mi. N. of Pedro Miguel; Pedro Miguel; Corozal; Miraflores Lock (all A. M. Chickering).

SPHYROTINUS VERUS, new species
Figures 357-359

Type. Male type from Santa Cruz, Veracruz, in the American Museum of Natural History.

Description. Carapace (Figs. 357, 358) modified like *S. illudens.* Palpus quite large. Total length of male 2.1 mm. Carapace 0.68 mm. long, 0.61 mm. wide. First femur, 0.85 mm.; patella and tibia, 0.80 mm.; metatarsus, 0.57 mm.; tarsus, 0.39 mm. Second patella and tibia, 0.66 mm.; third, 0.52 mm.; fourth, 0.68 mm.

Diagnosis. Details of the palpus (Fig. 359) differentiate this species from *S. illudens.*

SPHYROTINUS EXPULSUS (Gertsch and Mulaik), new combination
Figures 365-366

Paidisca expulsa, Levi, 1957, Bull. Amer. Mus. Nat. Hist., vol. 112, p. 109, figs. 400, 416, 417, ♀, ♂, map 39.

A female with a black head portion of the carapace and an epigynum with the posterior lip of the depression close to the margin and projecting (Fig. 366), from Soledad, Oriente, Cuba, Aug. 1-11, 1934 (P. J. Darlington) may be this species. A male from Morant Cays, Jamaica, June 1950 (C. B. Lewis), probably belongs to this species. This male has the whole carapace brown. The distribution of *S. expulsus* covers the southern United States south to Chiapas.

SPHYROTINUS DELICATULUS, new species
Figures 360-362

Type. Male holotype from Barro Colorado Island, Canal Zone, Aug. 21, 1954 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Anterior median eyes slightly smaller than others, one and one-half diameters apart, one-half their diameter from laterals. Posterior median eyes slightly more than one diameter apart, one diameter from laterals. A female measured total length 1.2 mm. Carapace 0.52 mm. long, 0.47 mm. wide. First femur 0.59 mm.; patella and tibia, 0.59 mm.; metatarsus, 0.34 mm.; tarsus, 0.29 mm. Second patella and tibia, 0.48 mm.; third, 0.36 mm.; fourth, 0.53 mm. A male measured total length 1.2 mm. Carapace 0.55 mm. long, 0.48 mm. wide. First femur, 0.60 mm.; patella and tibia, 0.58 mm.; metatarsus, 0.38 mm.; tarsus, 0.29 mm. Second patella and tibia, 0.47 mm.; third, 0.39 mm.; fourth, 0.55 mm.

Diagnosis. The genitalia (Figs. 360-362) distinguish this species from *S. expulsa.*

Natural History. This species has been found in hay and debris.

Records. Guerrero: Colotlipa (F. Bonet); Acahuizotla (F. Bonet). *Canal Zone:* Barro Colorado Island, ♀ allotype, ♀, ♂ paratypes (many collections); Chilibre; Corozal; Balboa; Experimental Gardens; Fort Clayton; Summit; Gatun; France Field; Gamboa; across canal from Pedro Miguel; 3 mi. N. of Pedro Miguel (all A. M. Chickering); Old Panama (C. D. Michener).

SPHYROTINUS MADERAE (Gertsch and Archer), new combination

Figures 350-356

Paidisca maderae, Levi, 1957, Bull. Amer. Mus. Nat. Hist., vol. 112, p. 106, figs. 397, 398, 420, 421, ♀, ♂; map 37.

Genitalia of specimens from Panama differ considerably from those of the southwestern United States; however, intermediates have been found in Mexico. Thus the specimens examined may all belong to one species. A palpus of a male from every collection is illustrated (Figs. 350-354). The carapace is highest in males from Arizona, of near normal shape in those from Panama; the carapace of males from Mexico is intermediate in height. The seminal receptacles are closer to the border in females from Panama and Mexico (Fig. 356), than in those from Arizona.

Distribution. Arizona to Panama.

Records. Nuevo Léon: 28 mi. N. of Monterrey (L. I. Davis). *Veracruz:* Veracruz (C. J. Goodnight); Tierra Blanca (C. and M. Goodnight). *Guerrero:* Acapulco (L. I. Davis). *Costa Rica:* San José (E. Schmidt). *Canal Zone:* Experimental Gardens; Gamboa; Summit; Pedro Miguel; Corozal (A. M. Chickering).

SPHYROTINUS MARXI (Crosby), new combination
Figures 363-364

Paidisca marxi, Levi, 1957, Bull. Amer. Mus. Nat. Hist., vol. 112, p. 111, figs. 393-395, 401, 418-419, ♀, ♂, map 41.

The ducts of the southernmost females of this heavily sclerotized species have a slightly different course (Fig. 364).

Distribution. Connecticut, southeastern United States, south to Chiapas.

Additional records. Puebla: Tehuacán (W. J. Gertsch and V. Roth). *Chiapas:* Unión Juárez (C. and M. Goodnight).

SPHYROTINUS CHIAPENSIS, new species
Figures 367-368

Type. Female type from San Cristóbal, Chiapas, July 21, 1950 (C. and M. Goodnight), in the American Museum of Natural History.

Description. Anterior eyes slightly smaller than others, their diameter apart, their radius from laterals. Posterior eyes their diameter apart. Total length of female 1.4 mm. Carapace 0.69 mm. long, 0.65 mm. wide. First femur, 0.78 mm.; patella and tibia, 0.75 mm.; metatarsus, 0.50 mm.; tarsus, 0.35 mm. Second patella and tibia, 0.62 mm.; third, 0.52 mm.; fourth, 0.66 mm.

Diagnosis. The epigynum having the openings in two dark spots (Fig. 368) and the winding connecting ducts (Fig. 367) differentiate this species from *S. notabilis.*

Record. Chiapas: San Cristóbal, ♀ paratype (C. and M. Goodnight).

SPHYROTINUS BONETI, new species
Figures 369-370

Type. Female type from Atoyac, Veracruz, Mexico, Nov. 12, 1941 (F. Bonet), in the American Museum of Natural History.

Description. Color very light. Diameter of anterior median eyes, half that of others. Anterior median eyes their diameter apart, one-third diameter from laterals. Posterior median eyes one diameter apart, a radius from laterals. The duct of the genitalia (Fig. 369) is difficult to discern. Total length of female 1.2 mm. Carapace 0.45 mm. long, 0.43 mm. wide. First femur, 0.44 mm.; patella and tibia, 0.50 mm.; metatarsus, 0.26 mm.; tarsus, 0.27 mm. Second patella and tibia, 0.40 mm.; third, 0.35 mm.; fourth 0.52 mm.

The generic placement of this species is uncertain.

Diagnosis. This species differs from other *Sphyrotinus* by having relatively long fourth legs, by having the tarsi longer than the metatarsi, and by the structure of the epigynum (Fig. 370).

Record. Veracruz. Atoyac, ♀ paratype (F. Bonet).

SPHYROTINUS ORILLA, new species

Figures 383-384

Type. Male type from Orilla, Río Armería, Tecomán, Colima. Jan. 18, 1943 (F. Bonet), in the American Museum of Natural History.

Description. Anterior median eyes three-quarters diameter apart, their radius from laterals. Posterior eyes separated by a diameter. Abdomen with a dorsal scutum (Fig. 384). Total length of male 1.5 mm. Carapace, 0.72 mm. long, 0.64 mm. wide. First femur, 0.67 mm.; patella and tibia, 0.66 mm.; metatarsus, 0.39 mm.; tarsus, 0.29 mm. Second patella and tibia, 0.53 mm.; third, 0.42 mm.; fourth, 0.60 mm.

Diagnosis. This species differs from *S. illudens* in lacking a modified clypeus, in having a dorsal and ventral scutum connected (Fig. 384), and in the shape of the visible ducts of the palpus (Fig. 383).

SPHYROTINUS CORUS, new species

Figures 373-374

Type. Female type from Las Ruinas de Palenque, Chiapas, July 1948 (C. and M. Goodnight), in the American Museum of Natural History.

Description. Abdomen black. Anterior median eyes their diameter apart, one-quarter from laterals. Posterior eyes their diameter apart. Total length of female 1.1 mm. Carapace 0.52 mm. long, 0.45 mm. wide. First femur, 0.52 mm.; patella and tibia, 0.50 mm.; metatarsus, 0.30 mm.; tarsus, 0.25 mm. Second patella and tibia, 0.39 mm.; third, 0.32 mm.; fourth, 0.43 mm.

Diagnosis. The long connecting ducts (Fig. 373) of the female genitalia separate this species from other species.

SPHYROTINUS BRADTI, new species

Figures 371-372

Type. Female type from Torrecillas, Chihuahua, 6900 ft., Aug. 17, 1947 (G. M. Bradt), in the American Museum of Natural History.

Description. Carapace, sternum, legs yellow; abdomen whitish. Anterior median eyes smaller than others, two diameters apart, three-fourths from laterals. Posterior median eyes slightly more than a diameter apart. Total length of female 1.3 mm. Carapace 0.65 mm. long, 0.58 mm. wide. First femur, 0.71 mm.; patella and tibia, 0.85 mm.; metatarsus, 0.51 mm.; tarsus, 0.38 mm. Second patella and tibia, 0.65 mm.; third, 0.52 mm.; fourth, 0.78 mm.

Diagnosis. The epigynum has the openings in the center of a slight swelling (Fig. 372). The ducts are short and thick (Fig. 371). The genitalia as well as the small eyes separate this species from others.

SPHYROTINUS CONFRATERNUS (Banks)

Figure 382

Theridium confraternus Banks, 1898, Proc. California Acad. Sci., 3rd. ser., vol. 1, p. 236, pl. 14, fig. 11, ♂ (♂ type from Tepic, Mexico, destroyed). Roewer, 1942, Katalog der Araneae, vol. 1, p. 491.

Description. Anterior median eyes slightly larger than others, three-quarters their diameter apart, almost touching laterals. Posterior eyes two-thirds their diameter apart. A male measured total length 1.4 mm. Carapace 0.71 mm. long, 0.62 mm. wide. First femur, 0.71 mm.; patella and tibia, 0.75 mm.; metatarsus, 0.56 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.65 mm.; third, 0.55 mm.; fourth, 0.65 mm.

Diagnosis. The notch in the conductor of the palpus (Fig. 382) distinguishes this species from other *Sphyrotinus.*

Comments. Although Banks' description is inadequate and the type has been lost, the crude illustration shows a looping duct and a dark conductor, both characteristics of the species on hand. While no other species of *Sphyrotinus* has been reported from Tepic, this species has been collected from the vicinity of the type locality.

Records. Nayarit: 25 km. S. of Tepic (B. Malkin). *Canal Zone:* Barro Colorado Island; Experimental Gardens; Chilibre; Summit; Ft. Sherman (all A. M. Chickering).

SPHYROTINUS RESERVATUS, new species
Figures 375-376

Type. Female holotype from Forest Reserve, Canal Zone, Aug. 10-12, 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Anterior median eyes slightly smaller than others, one and one-quarter diameters apart, almost touching laterals. Posterior medians three-quarters diameter apart, almost touching laterals. Total length 1.3 mm. Carapace 0.60 mm. long, 0.53 mm. wide. First femur, 0.86 mm.; patella and tibia, 0.78 mm.; metatarsus, 0.52 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.62 mm.; third, 0.43 mm.; fourth, 0.62 mm.

Diagnosis. The posterior median eyes almost touching laterals and the epigynum (Fig. 376) differentiate this species from other *Sphyrotinus.*

SPHYROTINUS INDICATUS (Banks), new combination
Figures 377-381

Theridion indicatum Banks, 1929, Bull. Mus. Comp. Zool., vol. 69, p. 84, pl. 2, fig. 19, pl. 3, fig. 48, ♂ (♂ type from Barro Colorado, in the Museum of Comparative Zoology). Roewer, 1942, Katalog der Araneae, vol. 1, p. 494.

Description. Anterior median eyes their diameter apart in female, less than one diameter from laterals; posterior eyes their diameter apart. Carapace of male illustrated by Figures 379, 380. Legs relatively long. A female measured total length 1.2 mm. Carapace 0.52 mm. long, 0.52 mm. wide. First femur, 1.08

mm.; patella and tibia, 0.95 mm.; metatarsus, 0.69 mm.; tarsus, 0.47 mm. Second patella and tibia, 0.75 mm.; third, 0.59 mm.; fourth, 0.80 mm. A male measured total length 1.4 mm. Carapace 0.80 mm. long, 0.52 mm. wide. First femur, 1.24 mm.; patella and tibia, 1.12 mm.; metatarsus, 0.82 mm.; tarsus, 0.44 mm. Second patella and tibia, 0.89 mm.; third, 0.66 mm.; fourth, 0.95 mm.

Records. Nicaragua: Musawas; Río Waspuc (B. Malkin). *Panama:* El Valle (A. M. Chickering). *Canal Zone:* Barro Colorado Island (very many collections); Forest Reserve (all A. M. Chickering).

SPHYROTINUS STYLIFRONS (Simon), new combination

Figures 385-389

Theridion stylifrons Simon, 1894, Proc. Zool. Soc. London, p. 523, fig. 4, ♂ (♀, ♂ syntypes from St. Vincent Island, in the British Museum, Natural History). Roewer, 1942, Katalog der Araneae, vol. 1, p. 498.

Description. Anterior median eyes of female one diameter apart, almost touching laterals. Posterior median eyes their radius apart, two-thirds their diameter from laterals. Carapace and eye arrangement of male illustrated by Figures 385, 386. Epigynum showing two small black spots some distance from the margin. Total length of females 0.9-1.3 mm. A female from Canal Zone measured total length 1.3 mm. Carapace 0.52 mm long, 0.45 mm. wide. First femur, 0.65 mm.; patella and tibia, 0.62 mm.; metatarsus, 0.43 mm.; tarsus, 0.30 mm. Second patella and tibia, 0.50 mm.; third, 0.36 mm.; fourth, 0.52 mm. A male from Canal Zone measured total length 1.4 mm. Carapace 1.02 mm long, 0.49 mm. wide. First femur, 0.71 mm.; patella and tibia, 0.70 mm.; metatarsus, 0.48 mm.; tarsus, 0.31 mm. Second patella and tibia. 0.52 mm.; third, 0.40 mm.; fourth, 0.55 mm.

Comments. A male and female syntype were examined.

Records. Panama: Arraiján (A. M. Chickering). *Canal Zone:* Balboa; Barro Colorado Island (many collections); Forest Reserve; Experimental Gardens; Chiva Road nr. Pedro Miguel; Ft. Sherman; Madden Dam; Summit (all A. M. Chickering). *Venezuela:* (Simon, 1894).

SPHYROTINUS BANKSI (Bryant), new combination
Figures 398-400

Thymoella banksi Bryant, 1948, Bull. Mus. Comp. Zool., vol. 100, p. 378, figs. 58, 62, 65, 66, ♂; not figs. 59, 64, ♀ (♂ holotype from Loma Rucilla Mts. 5000-8000 ft. Cordillera Central, Dominican Republic, in the Museum of Comparative Zoology).

Comments. The female allotype has a large colulus and is a linyphiid, not a theridiid.

SPHYROTINUS PIARCO, new species
Figures 390-394

Type. Male holotype, from Piarco, Trinidad, Jan. 3-6, 1955 (A. M. Nadler), in the American Museum of Natural History.

Description. Anterior median eyes slightly larger than others; in female one and one-quarter diameters apart, their radius from laterals; posterior median eyes one and one-half diameters apart, one diameter from laterals. Carapace of male modified (Figs. 392-393). Total length of female 1.4 mm. Carapace 0.65 mm. long, 0.53 mm. wide. First femur, 0.75 mm.; patella and tibia, 0.68 mm.; metatarsus, 0.50 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.53 mm.; third, 0.40 mm.; fourth, 0.62 mm. Total length of male 1.5 mm. Carapace 0.82 mm. long, 0.53 mm. wide. First femur, 0.74 mm.; patella and tibia, 0.66 mm.; metatarsus, 0.50 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.61 mm.; third, 0.43 mm.; fourth, 0.64 mm.

Diagnosis. The genitalia (Figs. 391, 394) distinguish this species from *S. simla.*

Records. Lesser Antilles: Trinidad: nr. Port of Spain, 1913, ♀ (R. Thaxter); Piarco, Jan. 3-6, 1955, ♀ (A. M. Nadler).

SPHYROTINUS SIMLA, new species
Figures 401-403

Type. Male holotype from Simla, near Arima, Trinidad, Dec. 29-30, 1954 (A. M. Nadler), in the American Museum of Natural History.

Description. Modified carapace illustrated by Figures 401-402. Total length 1.6 mm. Carapace 0.90 mm long, 0.62 mm. wide. First femur, 0.78 mm.; patella and tibia, 0.80 mm.; metatarsus, 0.50 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.65 mm.; third, 0.50 mm.; fourth, 0.66 mm.

Diagnosis. The genitalia (Fig. 403) distinguish this species from *S. piarco.*

Comment. The long connecting canals of the female collected with *S. piarco* might suggest that it is actually the female of *S. simla* which has a long embolus.

Distribution. Known only from type specimen collected at Trinidad.

SPHYROTINUS MATACHIC, new species

Figures 395-397

Type. Male type from Matáchic, Chihuahua, July 6, 1947 (W. J. Gertsch), in the American Museum of Natural History.

Description. Carapace modified (Figs. 395, 396). Abdomen with a dorsal scutum and a separate ventral scutum having the opening for the pedicel almost in the center; a sclerotic ring around spinnerets; several sclerotic spots on each side and setae from small sclerotic spots. Total length 1.2 mm. Carapace 0.65 mm. long, 0.55 mm. wide. First femur, 0.52 mm.; patella and tibia, 0.55 mm.; metatarsus, 0.28 mm.; tarsus, 0.28 mm. Second patella and tibia, 0.40 mm.; third, 0.36 mm.; fourth, 0.52 mm.

Diagnosis. The modified carapace, heavily sclerotized body and the palpus (Fig. 397) distinguish this species from others.

SPHYROTINUS INSIGNIS (O. P. Cambridge), new combination

Figures 404-410

Hubba insignis O. P. Cambridge, 1897, Biologia Centrali Americana, Araneidea, vol. 1, p. 231, pl. 30, fig. 4, ♂ (♂ type from Senahu, Guatemala, probably lost). Bonnet, 1957, Bibliographia Araneorum, vol. 3, p. 2236.

Theridion insigne, Roewer, 1942, Katalog der Araneae, vol. 1, p. 494.

Description. Anterior median eyes slightly smaller than others, two and one-half diameters apart in female, their radius from laterals; posterior median eyes one diameter apart, two-thirds of one from laterals. Male carapace modified (Figs. 406, 407). A female measured total length, 1.3 mm. Carapace 0.57 mm. long, 0.55 mm. wide. First femur, 0.80 mm.; patella and tibia, 0.78 mm.; metatarsus, 0.59 mm.; tarsus, 0.37 mm. Second patella and tibia, 0.65 mm.; third, 0.45 mm.; fourth, 0.78 mm. A male measured total length 1.3 mm. Carapace 0.73 mm. long, 0.56 mm. wide. First femur, 0.87 mm.; patella and tibia, 0.87 mm.; metatarsus, 0.65 mm.; tarsus, 0.37 mm. Second patella and tibia, 0.65 mm.; third, 0.46 mm.; fourth, 0.48 mm.

Comments. The vial containing the type, in the British Museum (Natural History), was also found to contain specimens which belonged to another species. Apparently F. P. Cambridge examined the latter and decided that this species is a linyphiid.

Natural History. This species has been collected with Berlese funnels.

Records. Canal Zone: Barro Colorado Island (many collections); Forest Reserve (A. M. Chickering).

SPHYROTINUS NOTABILIS, new species
Figures 411-416

Type. Male type from Summit, Canal Zone, 7-10 July 1950 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Fourth leg with dusky lines on each side; abdomen with four dusky areas on dorsum, one pair anterior, one posterior. Anterior median eyes half the diameter of others, two and one-half diameters apart in female, their radius from laterals; posterior median eyes their diameter apart, two-thirds their diameter from laterals. Carapace of male modified (Figs. 413, 414). A female measured total length 1.3 mm.; carapace 0.57 mm. long, 0.52 mm. wide. First femur, 0.80 mm.; patella and tibia, 0.83 mm.; metatarsus, 0.62 mm.; tarsus, 0.35 mm. Second patella and tibia, 0.62 mm.; third, 0.47 mm.; fourth, 0.73 mm. A male measured total length 1.3 mm. Carapace 0.70 mm. long, 0.60 mm. wide. First femur, 0.91 mm.; patella and tibia 1.00 mm.; metatarsus, 0.68 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.73 mm.; third, 0.51 mm.; fourth, 0.77 mm.

Diagnosis. The carapace of the male is not circular in outline (Fig. 414) as is that of *S. insignis* (a character mentioned by O. P. Cambridge). The median apophysis has a long projecting process in *S. notabilis* (Fig. 415), lacking in *S. insignis.* The openings of the epigynum are in the center of sclerotized disks in *S. notabilis* (Fig. 412), at the posterior of a small depression in *S. insignis.*

Records. Canal Zone: Summit, ♀ allotype, ♂, ♀ paratypes, 7-10 July 1950; 21-29 July 1950; Aug. 1950 (A. M. Chickering); Pedro Miguel, Jan. 1958 (A. M. Chickering).

SPHYROTINUS BOGUS, new species
Figures 417-418

Type. Female type from Boquete, Panama, July 10-25, 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Diameter of anterior median eyes one-half that of other eyes. Anterior median eyes one diameter apart, three-quarters from laterals. Posterior eyes slightly oval, their shortest radius apart. Total length 2.0 mm. Carapace 0.72 mm. long, 0.70 mm. wide. First femur, 0.80 mm.; patella and tibia, 0.84 mm.; metatarsus, 0.58 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.72 mm.; third, 0.60 mm.; fourth, 0.79 mm.

Diagnosis. The epigynum (Fig. 418) distinguishes this species from other species of the genus.

Record. Panama: Boquete, ♀ paratype (A. M. Chickering); El Volcán (W. J. Gertsch).

SPHYROTINUS BOQUETE, new species
Figures 419-422

Type. Male holotype from Boquete, Panama, July 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Carapace, sternum, legs, yellow-brown. Abdomen white to gray. Anterior median eyes smaller than others, one and one-quarter diameters apart, about one diameter from laterals. Posterior median eyes a little more than one diameter apart, one and one-half diameters from laterals. Measurements of female 1.8 mm. total length. Carapace 0.88 mm. long, 0.78 mm. wide. First femur, 1.04 mm.; patella and tibia, 1.04 mm.; metatarsus, 0.69 mm.; tarsus, 0.48 mm. Second patella and tibia, 1.00 mm.; third, 0.66 mm.; fourth, 0.85 mm.

Diagnosis. This species differs from others by having an epigynum with a projecting posterior lip (Figs. 420-422); and a palpus whose embolus is not visible in ventral view (Fig. 419).

Records. San Luis Potosí: Tamazunchale (F. Bonet; A. M. and L. I. Davis). *Veracruz:* 80 mi. SW. of Tuxpan (A. M. and

L. I. Davis); El Tajín (C. Goodnight and Bordas). *Tabasco:* Baños de Sulfre nr. Teapa (C. and M. Goodnight). *Chiapas:* Huitxla; Pichucalco (C. and M. Goodnight). *Costa Rica:* San José (E. Schmidt). *Panama:* Boquete, ♀ allotype, ♀, ♂ paratypes (A. M. Chickering); El Volcán (A. M. Chickering). *Canal Zone:* Forest Reserve (A. M. Chickering).

SPHYROTINUS SCLEROTIS (Levi), new combination

Paidisca sclerotis Levi, 1957, Bull. Amer. Mus. Nat. Hist., vol. 112, p. 104, figs. 384-387, ♀; map 37.

Distribution. New Mexico to Chihuahua.

Additional record. Chihuahua: Cañón Prieta nr. Primavera (W. J. Gertsch).

SPHYROTINUS MISSIONENSIS (Levi), new combination

Paidisca missionensis Levi, 1957, Bull. Amer. Mus. Nat. Hist., vol. 112, p. 102, figs. 380-383, ♀; map 37.

Distribution. Texas to Costa Rica.

SPHYROTINUS DEPRUS, new species
Figures 427-428

Type. Female type from Barro Colorado Island, Canal Zone, June 23-30, 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Dorsum of abdomen with a fine median dusky line; a dusky ring around spinnerets. Anterior median eyes slightly larger than others, two-thirds diameters apart, one-quarter from laterals. Posterior median eyes one diameter apart, two-thirds from laterals. Total length 1.4 mm. Carapace 0.78 mm. long, 0.70 mm. wide. First femur, 0.69 mm.; patella and tibia, 0.77 mm.; metatarsus, 0.52 mm.; tarsus, 0.41 mm. Second patella and tibia, 0.66 mm.; third, 0.55 mm.; fourth, 0.71 mm.

Diagnosis. A large oval depression in the epigynum (Fig. 428) distinguishes this species from other *Sphyrotinus.*

Records. San Luis Potosí: Pujal, cave entrance (W. Bridges). *Costa Rica:* San José (E. Schmidt). *Canal Zone:* Barro Colorado Isl., ♀ paratypes (A. M. Chickering); Chilibre, ♀; Experimental Gardens (A. M. Chickering).

SPHYROTINUS PALLIDUS (Emerton), new combination

Paidisca pallida, Levi, 1957, Bull. Amer. Mus. Nat. Hist., vol. 112, p. 99, figs. 358-366, ♀, ♂, map 35.

Distribution. From Massachusetts, Utah, Southern California, south to Central Mexico, Cuba, Hispaniola.

Additional Records. Nayarit: Compostela (W. J. Gertsch). *Jalisco:* W. side of Lago de Sayula (W. J. Gertsch and V. Roth). *Puebla:* Tlacotepec (V. Roth, W. J. Gertsch). *Dominican Republic:* Carr. Mella, 8 km. from Ciudad Trujillo (A. M. Nadler).

SPHYROTINUS PROLATUS, new species
Figures 423-426

Type. Male holotype, from Barro Colorado Island, Canal Zone, Aug. 1-6, 1939 (A. M. Chickering), in the Museum of Comparative Zoology.

Description. Anterior median eyes slightly larger or smaller than others. Anterior median eyes one and one-half diameters apart in female, two-thirds diameter from laterals; their radius apart in male, one-half their radius from laterals. Posterior eyes their diameter apart. A female measured total length 1.2 mm. Carapace 0.52 mm. long, 0.41 mm. wide. First femur, 0.80 mm.; patella and tibia, 0.78 mm.; metatarsus, 0.60 mm.; tarsus, 0.36 mm. Second patella and tibia, 0.62 mm.; third, 0.39 mm.; fourth, 0.65 mm. A male measured total length 1.3 mm. Carapace 0.53 mm. long, 0.53 mm. wide. First femur, 0.85 mm.; patella and tibia, 0.92 mm.; metatarsus, 0.66 mm.; tarsus, 0.35 mm. Second patella and tibia, 0.82 mm.; third, 0.54 mm.; fourth, 0.80 mm. It is assumed that the male and females described here belong together, but this is not absolutely certain.

Diagnosis. The epigynum (Fig. 426) is difficult to study; it is not known for certain if the ducts are above or below the seminal receptacles; the openings are small and on the posterior margin. The length of the palpal femur equals the length of the carapace (Fig. 423); the palpal femur is thicker than the femur of the first leg. The palpus faces ectally; the dorsal side of the cymbius is covered by long silky hair (Fig. 424).

Records. Canal Zone: Barro Colorado Island, ♀ allotype, ♀, ♂ paratypes (many records); Experimental Gardens; Madden Dam; Forest Reserve (all A. M. Chickering).

SPHYROTINUS VIVUS (O. P. Cambridge)
Figures 429-430

Theridion vivum O. P. Cambridge, 1899, Biologia Centrali Americana, vol. 1, p. 293, pl. 34, fig. 8, ♀ (♀ type from Costa Rica, in the British Museum, Natural History). Roewer, 1942, Katalog der Araneae, vol. 1, p. 500.

Steatoda viva, F. P. Cambridge, 1902, Biologia Centrali Americana, vol. 2, p. 385.

Index to Scientific Names

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Figs. 1-3. *Achaearanea turquino*, new species. 1. Female genitalia, dorsal view. 2-3. Epigynum. 2. Ventral view. 3. Lateral view.

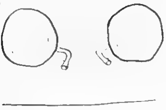
Figs. 4-8. *A. hermosillo*, new species, 4. Female genitalia, dorsal view. 5. Epigynum. 6-7. Left palpus. 6. Ventral view. 7. Ectal view. 8. Female.

Figs. 9-12. *A. apex*, new species. 9. Female genitalia, dorsal view. 10. Epigynum. 11. Female abdomen, lateral view. 12. Palpus.

Figs. 13-15. *A. anna*, new species. 13. Palpus. 14. Female genitalia, dorsal view. 15. Epigynum.

Fig. 16. *A. florens* (O. P. Cambridge), palpus.

Fig. 17. *A. florendida*, new species, palpus.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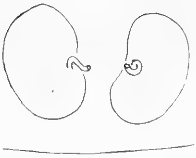
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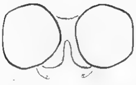
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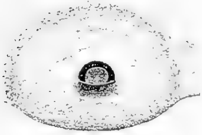
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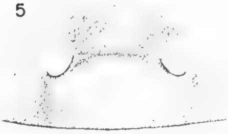
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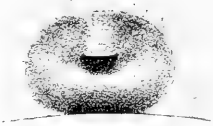
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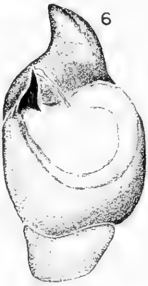
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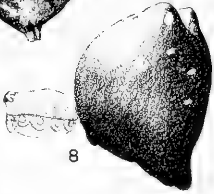
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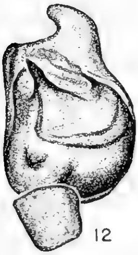
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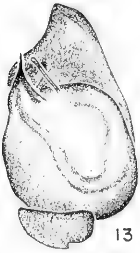
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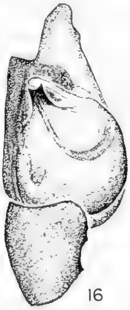
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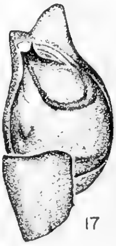
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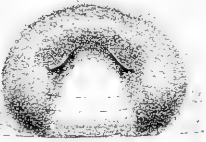
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Figs. 18-19. *Achaearanea florens* (O. P. Cambridge). 18. Female genitalia, dorsal view. 19. Epigynum.

Figs. 20-21. *A. florendida*, new species. 20. Female genitalia, dorsal view. 21. Epigynum.

Figs. 22-23. *A. serax*, new species. 22. Female genitalia, dorsal view. 23. Epigynum.

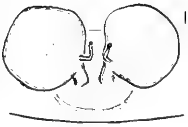
Figs. 24-25. *A. schraderorum*, new species. 24. Female genitalia, dorsal view. 25. Epigynum.

Fig. 26. *A. schneirlai*, new species, left palpus.

Figs. 27-28. *A. manzanillo*, new species. 27. Female genitalia, dorsal view. 28. Epigynum.

Figs. 29-31. *A. trinidensis*, new species. 29. Palpus. 30. Female genitalia, dorsal view. 31. Epigynum.

Figs. 32-34. *A. zonensis*, new species. 32. Female genitalia, dorsal view. 33. Epigynum. 34. Palpus.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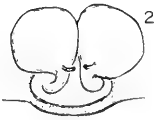
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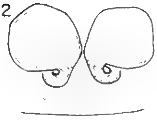
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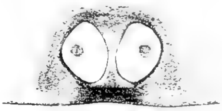
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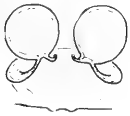
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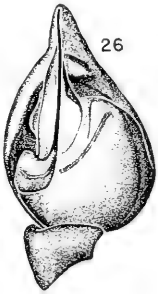
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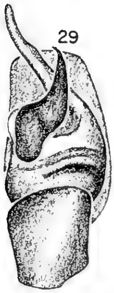
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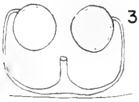
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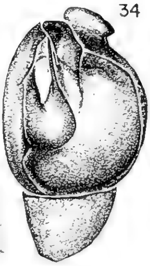
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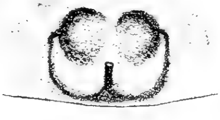
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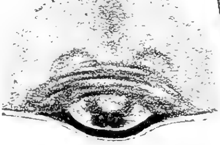
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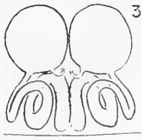
Figs. 35-38. *Achaearanea hirta* (Taczanowski). 35. Female genitalia, dorsal view. 36. Epigynum. 37. Left palpus. 38. Female.

Figs. 39-41. *A. taeniata* (Keyserling). 39. Female genitalia, dorsal view. 40. Epigynum. 41. Palpus.

Figs. 42-44. *A. pura* (O. P. Cambridge). 42. Female genitalia, dorsal view. 43. Epigynum. 44. Palpus.

Figs. 45-50. *A. maricaoensis* (Bryant). 45. Female. 46. Epigynum, cleared. 47. Female genitalia, dorsal view. 48. Epigynum. 49-50. Palpus. 49. (Panama). 50. (Puerto Rico).

Fig. 51. *A. machaera*, new species, palpus.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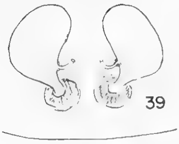
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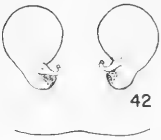
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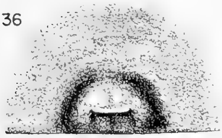
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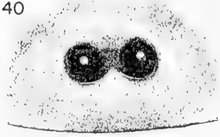
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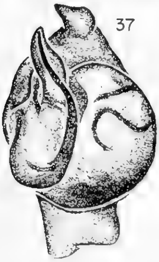
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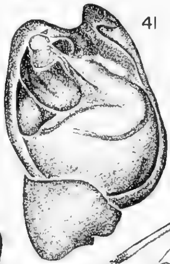
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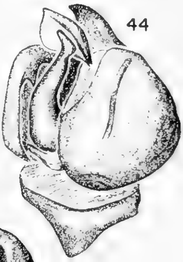
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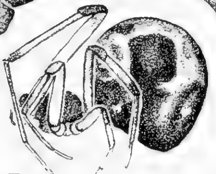
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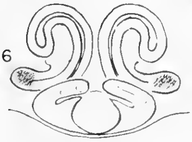
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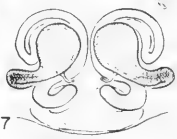
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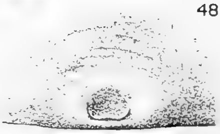
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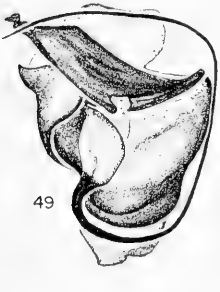
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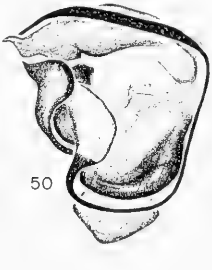
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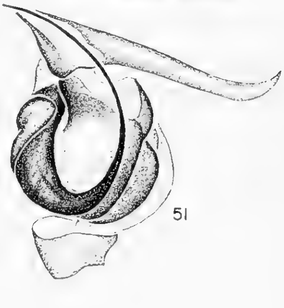
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Fig. 52. *Achaearanea terex,* new species, left palpus.

Figs. 53-56. *A. mesax,* new species. 53. Female. 54. Female genitalia, dorsal view. 55. Epigynum. 56. Palpus.

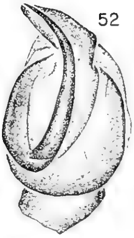
Figs. 57-60. *A. picadoi* (Banks). 57, 59. Female genitalia, dorsal view. 58, 60. Epigynum. 57-58. (Panama). 59-60. (Costa Rica).

Figs. 61-63. *A. obliria* (O. P. Cambridge). 61. Female genitalia, dorsal view. 62-63. Epigynum. 62. Ventral view. 63. Posterior view.

Figs. 64-66. *A. rostrata* (O. P. Cambridge). 64. Female genitalia, dorsal view. 65. Epigynum. 66. Lateral view.

Figs. 67-69. *A. nayaritensis,* new species. 67. Female genitalia, dorsal view. 68-69. Epigynum. 68. Ventral view. 69. Lateral view.

Figs. 70-71. *A. tessellata* (Keyserling). 70. Female genitalia, dorsal view. 71. Epigynum.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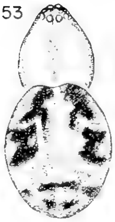
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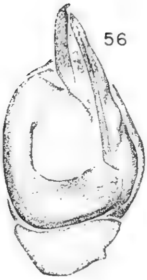
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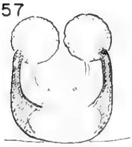
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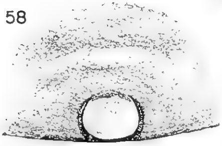
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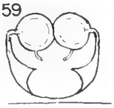
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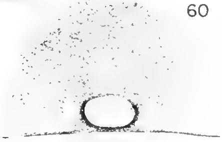
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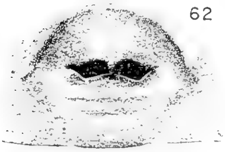
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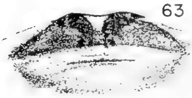
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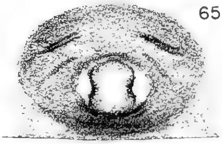
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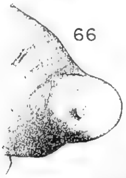
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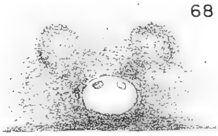
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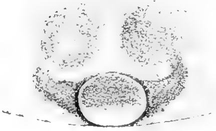
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Figs. 72-73. *Theridion davisorum*, new species. 72. Female genitalia, dorsal view. 73. Epigynum.

Figs. 74-75. *T. cameronense* Levi. 74. Female genitalia, dorsal view. 75. Epigynum.

Figs. 76-77. *T. bryantae* Roewer. 76. Female genitalia, dorsal view. 77. Epigynum.

Figs. 78-81. *T. dilucidum* Simon. 78. Female genitalia, dorsal view. 79. Epigynum. 80-81. Left palpus. 80. Mesal view. 81. Ventral view.

Figs. 82-86. *T. galerum*, new species. 82. Female genitalia, dorsal view. 83. Epigynum, ventral view. 84. Epigynum with plug, lateral view. 85. Palpus, mesal view. 86. Palpus, ventral view.

Figs. 87-88. *T. elisabethae* Roewer. 87. Female genitalia, dorsal view. 88. Epigynum.

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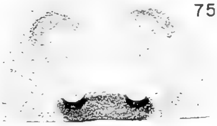

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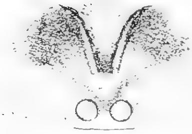

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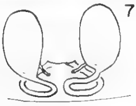

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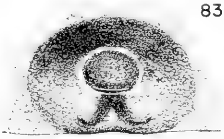

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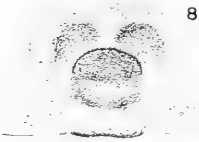

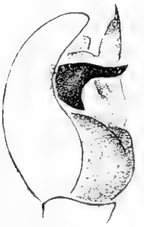

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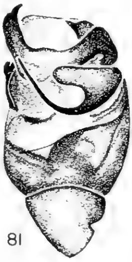

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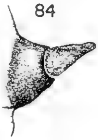

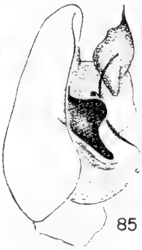

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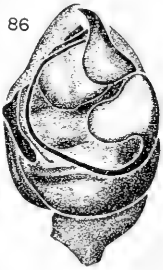

Figs. 89-90. *Theridion submissum* Gertsch and Davis. 89. Female genitalia, dorsal view. 90. Epigynum.

Figs. 91-92. *T. gertschi*, new species. 91. Female genitalia, dorsal view. 92. Epigynum.

Figs. 93-94. *T. archeri*, new species. 93. Female genitalia, dorsal view. 94. Epigynum.

Figs. 95-102. *T. hispidum* O. P. Cambridge. 95, 97, 99. Female genitalia, dorsal view. 96, 98, 100. Epigynum. 95-96. (Cuba). 97-98. (Veracruz). 99-100. (Panama). 101-102. Left palpus. 101. Mesal view. 102. Ventral view.

Figs. 103-104. *T. valleculum*, new species, palpus. 103. Mesal view. 104. Ventral view.

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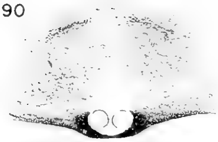

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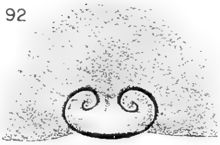

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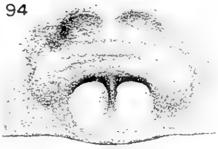

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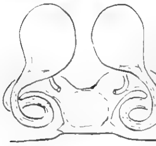

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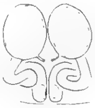

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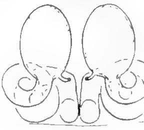

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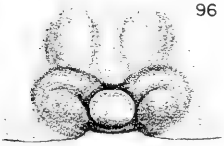

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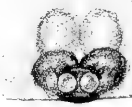

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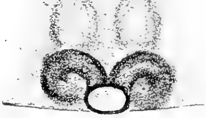

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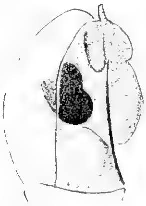

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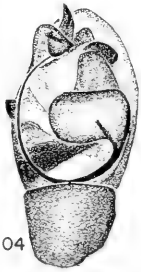

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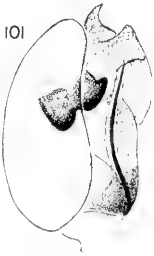

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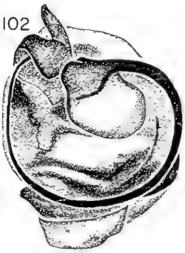

Figs. 105-106. *Theridion rothi*, new species, left palpus. 105. Mesal view. 106. Ventral view.

Figs. 107-110. *T. coyoacan*, new species. 107. Female genitalia, dorsal view. 108. Epigynum. 109. Palpus, mesal view. 110. Palpus, ventral view.

Figs. 111-117. *T. adjacens* (O. P. Cambridge). 111. Palpus, mesal view. 112. Palpus, ventral view. 113, 116. Female genitalia, dorsal view. 114, 115, 117. Epigynum.

Figs. 118-119. *T. sanctus*, new species. 118. Mesal view. 119. Ventral view.

Figs. 120-121. *T. barbarae*, new species, palpus. 120. Mesal view. 121. Ventral view.

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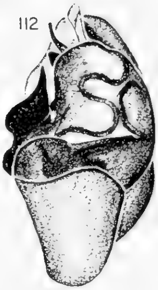

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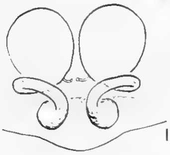

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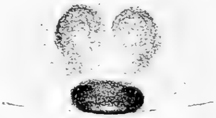

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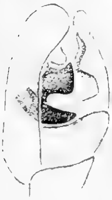

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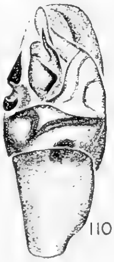

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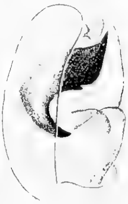

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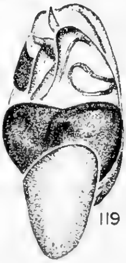

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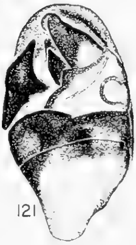

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Figs. 122-123. *Theridion barbarae*, new species. 122. Female genitalia, dorsal view. 123. Epigynum.

Figs. 124-135. *T. evexum* Keyserling. 124, 126. Female genitalia, dorsal view. 125, 127. Epigynum. 124-125. (Cuba). 126-127. (Panama). 128-135. Left palpus. 128, 130, 132, 134. Mesal view. 129, 131, 133, 135. Ventral view. 128-129. (Cuba). 130-131. (Hidalgo). 132-133 (Guatemala). 134-135. (Panama).

Figs. 136-137. *T. tristani*, new species, palpus. 136. Mesal view. 137. Ventral view.


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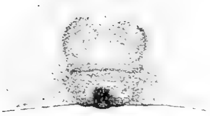
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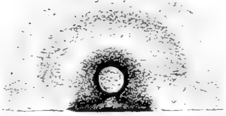
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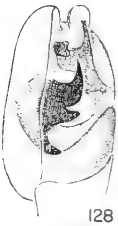
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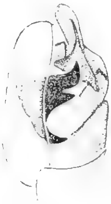
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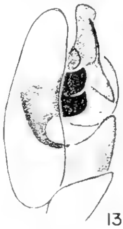
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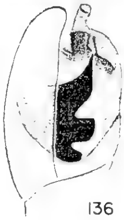
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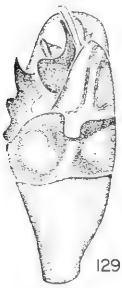
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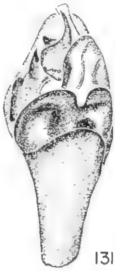
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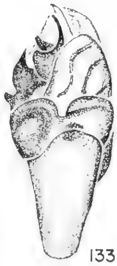
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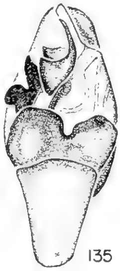
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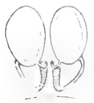
Figs. 138-141. *Theridion ricense*, new species. 138. Female genitalia, dorsal view. 139. Epigynum. 140-141. Left palpus. 140. Mesal view. 141. Ventral view.

Figs. 142-143. *T. crucum*, new species, palpus. 142. Mesal view. 143. Ventral view.

Figs. 144-147. *T. contreras*, new species. 144. Female genitalia, dorsal view. 145. Epigynum. 146-147. Palpus. 146. Mesal view. 147. Ventral view.

Figs. 148-151. *T. leones*, new species. 148. Female genitalia, dorsal view. 149. Epigynum. 150-151. Palpus. 150. Mesal view. 151. Ectal view.



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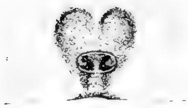

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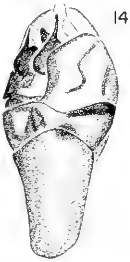

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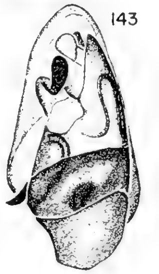

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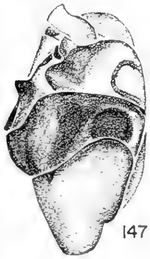

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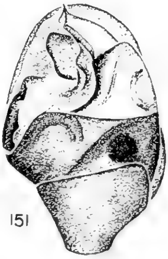

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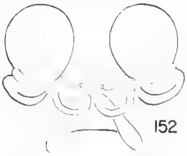
Figs. 152-158. *Theridion metabolum* Chamberlin and Ivie. 152. Female genitalia, dorsal view. 153. Epigynum. 154. Female abdomen, dorsal view. 155-158. Left palpus. 155, 157. Mesal view. 156, 158. Ventral view.

Figs. 159-161. *T. morulum* (O. P. Cambridge). 159. Female genitalia, dorsal view. 160-161. Epigynum. 160. Ventral view. 161. Lateral view.

Figs. 162-167. *T. niveum* O. P. Cambridge. 162. Female genitalia, dorsal view. 163-164. Epigynum. 163. Ventral view. 164. Lateral view. 165-167. Palpus. 165. Mesal view. 166, 167. Ventral view.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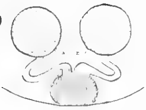
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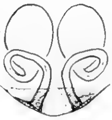
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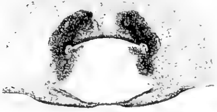
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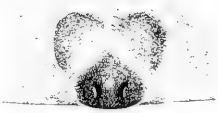
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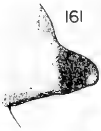
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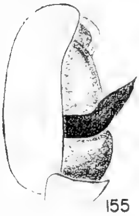
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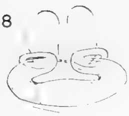
Figs. 168-171. *Theridion styligerum* F. P. Cambridge. 168. Female genitalia, dorsal view. 169. Epigynum. 170-171. Left palpus. 170. Mesal view. 171. Ventral view.

Figs. 172-176. *T. omiltemi,* new species. 172. Female genitalia, dorsal view. 173. Epigynum. 174. Female abdomen, ventral view. 175-176. Palpus. 175. Mesal view. 176. Ventral view.

Figs. 177-180. *T. trepidum* O. P. Cambridge. 177. Female genitalia, dorsal view. 178. Epigynum. 179-180. Palpus. 179. Mesal view. 180. Ventral view.

Figs. 181-182. *T. martini,* new species, palpus. 181. Mesal view. 182. Ventral view.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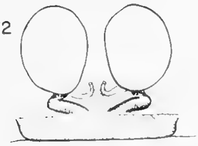
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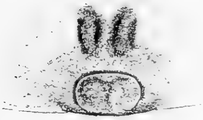
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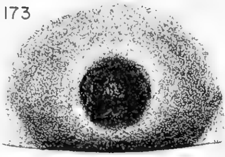
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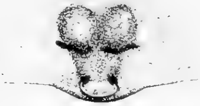
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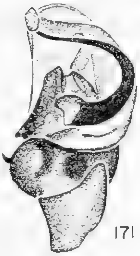
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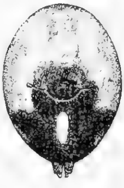
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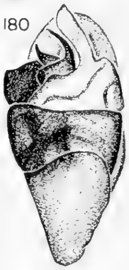
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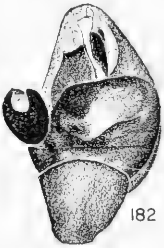
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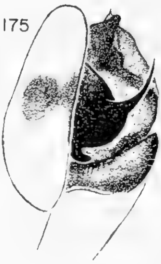
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Figs. 183-184. *Theridion turrialba*, new species. 183. Female genitalia, dorsal view. 184. Epigynum.

Figs. 185-186. *T. grecia*, new species. 185. Female genitalia, dorsal view. 186. Epigynum.

Figs. 187-188. *T. apulco*, new species. 187. Female genitalia, dorsal view. 188. Epigynum.

Figs. 189-190. *T. bolivari*, new species. 189. Female genitalia, dorsal view. 190. Epigynum.

Figs. 191-192. *T. chihuahua*, new species. 191. Female genitalia, dorsal view. 192. Epigynum.

Figs. 193-194. *T. hondurense*, new species. 193. Female genitalia, dorsal view. 194. Epigynum.

Figs. 195-196. *T. biolleyi* Banks. 195. Female genitalia, dorsal view. 196. Epigynum.

Figs. 197-198. *T. rulrum*, new species. 197. Female genitalia, dorsal view. 198. Epigynum.

Figs. 199-200. *T. frio*, new species. 199. Female genitalia, dorsal view. 200. Epigynum.

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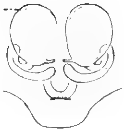

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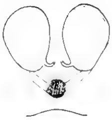

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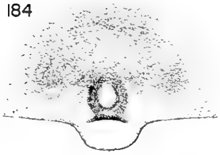

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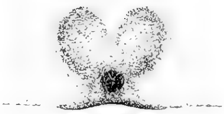

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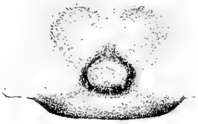

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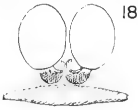

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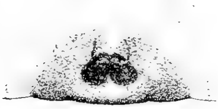

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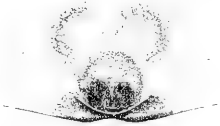

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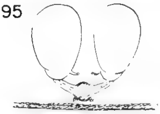

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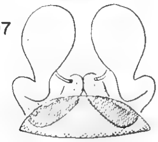

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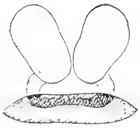

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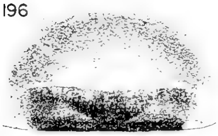

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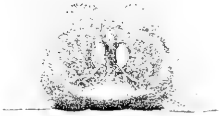

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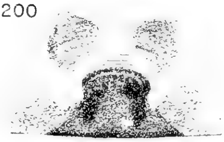


Figs. 201-202. *Theridion dreisbachi*, new species, left palpus. 201. Mesal view. 202. Ventral view.

Figs. 203-204. *T. uncatum* F. P. Cambridge, palpus. 203. Mesal view. 204. Ventral view.

Fig. 205. *T. cavipalpe* (F. P. Cambridge), palpus, ventral view.

Figs. 206-207. *T. excavatum* F. P. Cambridge. 206. Female genitalia, dorsal view. 207. Epigynum.

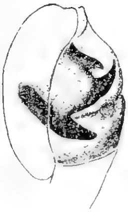
Figs. 208-209. *T. centrum*, new species. 208. Female genitalia, dorsal view. 209. Epigynum.

Figs. 210-211. *T. akme*, new species. 210. Female genitalia, dorsal view. 211. Epigynum.

Fig. 212. *T. sinaloa*, new species, palpus.

Figs. 213-215. *T. albulum* O. P. Cambridge. 213. Female genitalia, dorsal view. 214. Epigynum. 215. Palpus.

Figs. 216-218. *T. cazieri*, new species. 216. Female genitalia, dorsal view. 217. Epigynum. 218. Palpus.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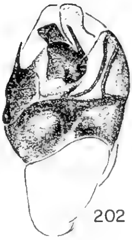
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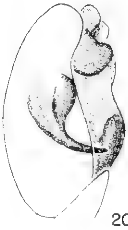
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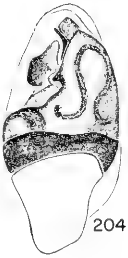
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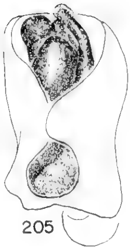
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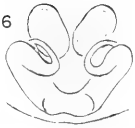
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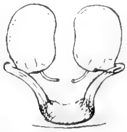
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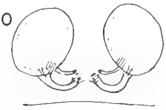
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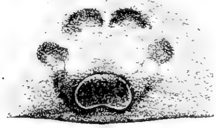
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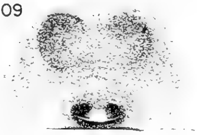
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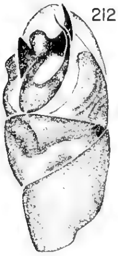
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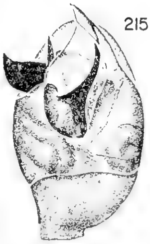
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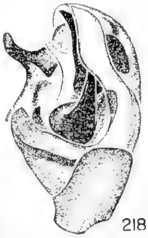
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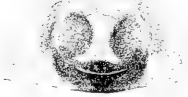
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Figs. 219-222. *Theridion jamaicense*, new species. 219. Female genitalia, dorsal view. 220. Epigynum. 221. Epigynum, lateral view. 222. Left palpus.

Figs. 223-226. *T. antillanum* Simon. 223. Female genitalia, dorsal view. 224. Epigynum. 225-226. Palpus. 225. Submesal view, expanded. 226. Ventral view.

Figs. 227-229. *T. nudum*, new species. 227. Female genitalia, dorsal view. 228. Epigynum. 229. Palpus.

Figs. 230-233. *T. rufipunctum*, new species. 230. Female abdomen, dorsal view. 231. Palpus. 232. Female genitalia, dorsal view. 233. Epigynum.

Abbreviations: C, conductor; *E*, embolus; *M*, median apophysis.


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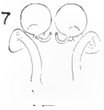
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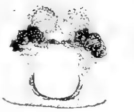
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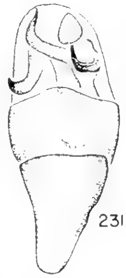
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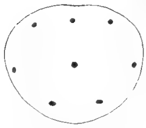
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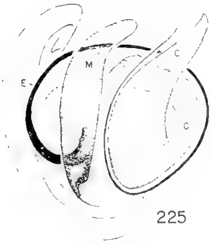

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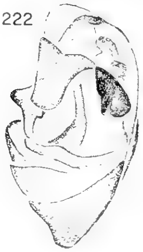
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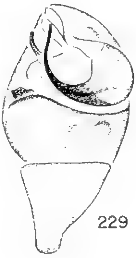
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Figs. 234-235. *Theridion barroanum*, new species. 234. Female genitalia, dorsal view. 235. Epigynum.

Figs. 236-239. *T. sexmaculatum* Keyserling. 236. Female genitalia, dorsal view. 237. Epigynum. 238. Female abdomen, dorsal view. 239. Left palpus.

Figs. 240-241. *T. nadleri*, new species. 240. Female genitalia, dorsal view. 241. Epigynum.

Figs. 242-244. *T. pallisterorum*, new species. 242. Female genitalia, dorsal view. 243. Epigynum. 244. Palpus.

Figs. 245-248. *T. dotanum* (Banks). 245. Female genitalia, dorsal view. 246. Epigynum. 247. Female abdomen, dorsal view. 248. Palpus.

Fig. 249. *T. minutissimum* Keyserling, palpus.


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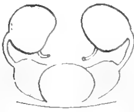
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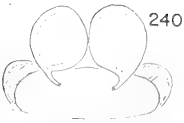
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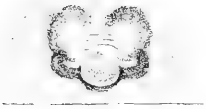
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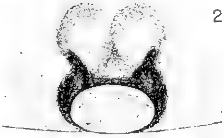
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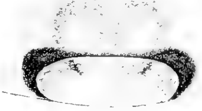
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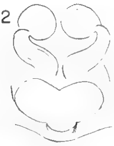
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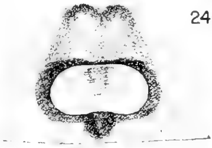
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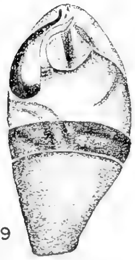
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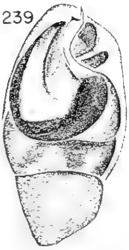
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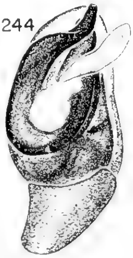
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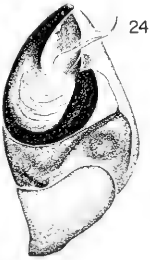
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Figs. 250-252. *Theridion akron*, new species. 250. Female genitalia, dorsal view. 251. Epigynum. 252. Left palpus.

Figs. 253-254. *T. resum*, new species. 253. Female genitalia, dorsal view. 254. Epigynum.

Figs. 255-256. *T. plantatum*, new species. 255. Female genitalia, dorsal view. 256. Epigynum.

Figs. 257-258. *T. quemadum*, new species. 257. Female genitalia, dorsal view. 258. Epigynum.

Figs. 259-260. *T. armouri*, new species. 259. Female genitalia, dorsal view. 260. Epigynum.

Figs. 261-262. *T. rinconense*, new species. 261. Female genitalia, dorsal view. 262. Epigynum.

Figs. 263-267. *T. panamense*, new species. 263. Female genitalia, dorsal view. 264. Epigynum. 265-266. Palpus (same locality). 267. Female abdomen, ventral view.

Figs. 268-271. *T. chiriqui*, new species. 268. Palpus. 269. Male abdomen, dorsal view. 270. Female genitalia, dorsal view. 271. Epigynum.


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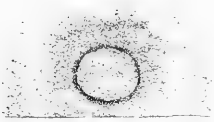
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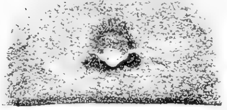
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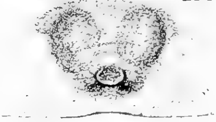
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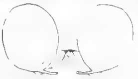
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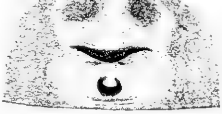
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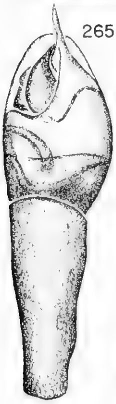
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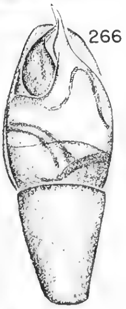
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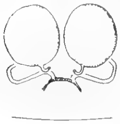
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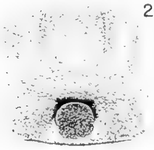
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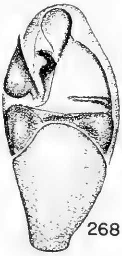
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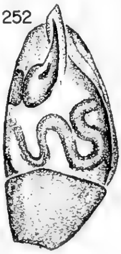
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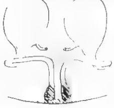
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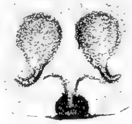
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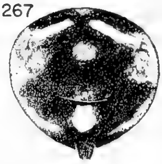
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Figs. 272-276. *Theridion lathropi*, new species. 272. Female genitalia, dorsal view. 273. Epigynum, lateral view. 274. Epigynum. 275-276. Left palpus. 275. Mesal view, expanded. 276. Ventral view.

Figs. 277-279. *T. colima*, new species. 277. Female genitalia, dorsal view. 278. Epigynum, lateral view. 279. Epigynum.

Figs. 280-284. *T. petrum*, new species. 280. Female genitalia, dorsal view. 281. Epigynum, lateral view. 282. Epigynum. 283. Female. 284. Palpus.

Figs. 285-288. *T. moctezuma*, new species. 285. Female genitalia, dorsal view. 286. Epigynum. 287. Female abdomen, dorsal view. 288. Palpus.

Figs. 289-290. *T. panum*, new species. 289. Female genitalia, dorsal view. 290. Epigynum.

Abbreviations: C, conductor; *E*, embolus; *M*, median apophysis; *R*, radix.

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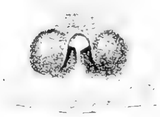

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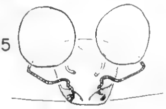

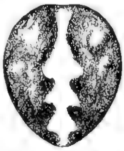

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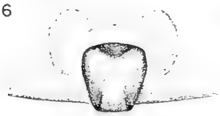

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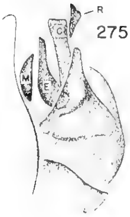

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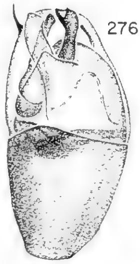

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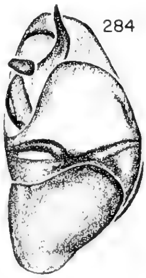

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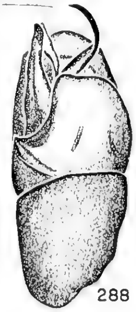

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Figs. 291-292. *Theridion cobanum*, new species. 291. Female genitalia, dorsal view. 292. Epigynum.

Figs. 293-294. *T. quantum*, new species. 293. Female genitalia, dorsal view. 294. Epigynum.

Figs. 295-296. *T. malkini*, new species. 295. Female genitalia, dorsal view. 296. Epigynum.

Figs. 297-298. *T. signum*, new species. 297. Female genitalia, dorsal view. 298. Epigynum.

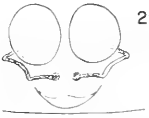
Figs. 299-300. *T. paidiscum*, new species. 299. Female genitalia, dorsal view. 300. Epigynum.

Figs. 301-302. *T. signaculum*, new species. 301. Female genitalia, dorsal view. 302. Epigynum.

Figs. 303-304. *T. atlixco*, new species. 303. Female genitalia, dorsal view. 304. Epigynum.

Figs. 305-306. *T. progum*, new species. 305. Female genitalia, dorsal view. 306. Epigynum.

Figs. 307-308. *T. bridgesi*, new species. 307. Female genitalia, dorsal view. 308. Epigynum.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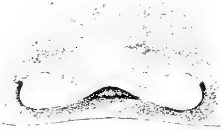
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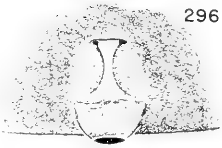
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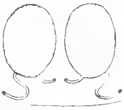
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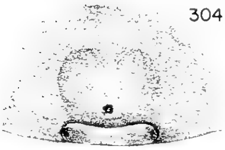
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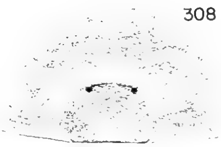
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Figs. 309-310. *Theridion chilapa*, new species. 309. Female genitalia, dorsal view. 310. Epigynum.

Figs. 311-312. *T. aspersum* (F. P. Cambridge). 311. Female genitalia, dorsal view. 312. Epigynum.

Figs. 313-314. *T. artum*, new species. 313. Female genitalia, dorsal view. 314. Epigynum.

Figs. 315-316. *T. tempum*, new species. 315. Female genitalia, dorsal view. 316. Epigynum.

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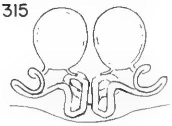

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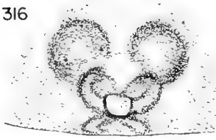

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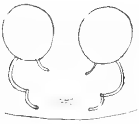

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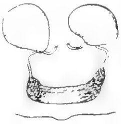

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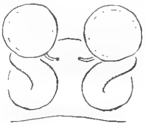

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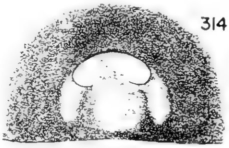


Fig. 317. *Theridion quantum*, new species, left palpus.

Figs. 318-321. *T. reservum*, new species. 318. Female genitalia, dorsal view. 319. Epigynum. 320. Female abdomen, dorsal view. 321. Palpus.

Figs. 322-324. *T. clemens*, new species. 322. Female genitalia, dorsal view. 323. Epigynum. 324. Palpus.

Fig. 325. *T. ruinum*, new species, palpus.

Fig. 326. *T. marrum*, new species, palpus.

Fig. 327. *T. musawas*, new species, palpus.

Fig. 328. *T. bridgesi*, new species, palpus.

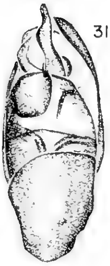
Figs. 329-330. *T. paidiscum*, new species, palpus. 329. Expanded, dorsal view, cymbium removed. 330. Ventral view.

Fig. 331. *T. schmidti*, new species, palpus.

Fig. 332. *T. signum*, new species, palpus.

Fig. 333. *T. signaculum*, new species, palpus.

Abbreviations: C, conductor; *E*, embolus; *M*, median apophysis.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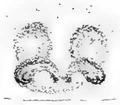
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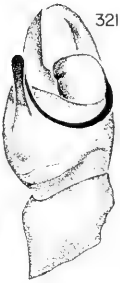
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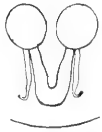
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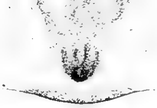
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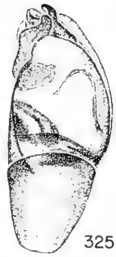
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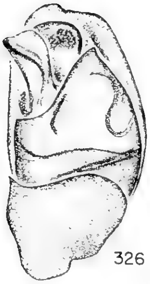
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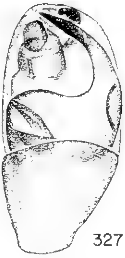
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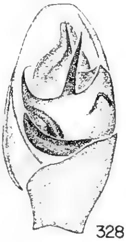
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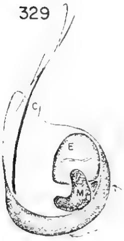

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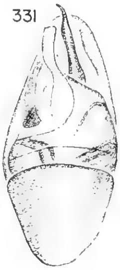
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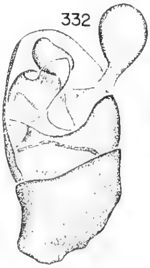
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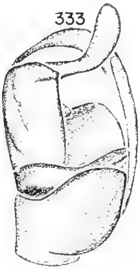
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Figs. 334-338. *Sphyrotinus luculentus,* Simon. 334. Female genitalia, dorsal view. 335. Epigynum (St. Vincent Island). 336-338. Left palpus. 336. (Syntype from St. Vincent Island). 337 .(Panama). 338. (Chiapas).

Figs. 339-341. *S. chickeringi,* new species. 339. Female genitalia, dorsal view. 340. Epigynum. 341. Palpus.

Figs. 342-344. *S. illudens* (Gertsch and Mulaik), (Panama). 342. Female genitalia, dorsal view. 343. Epigynum. 344. Palpus.

Figs. 345-349. *S. guanicae* (Petrunkevitch), (Jamaica). 345, 347. Epigynum. 346. Female genitalia, dorsal view. 348-349. Palpus.


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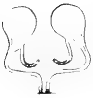
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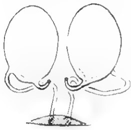
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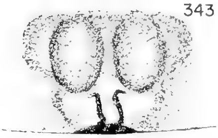
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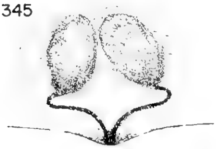
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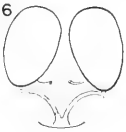
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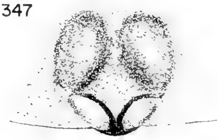
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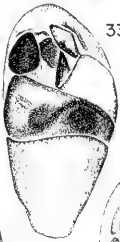
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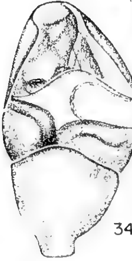
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Figs. 350-356. *Sphyrotinus maderae* (Gertsch and Archer), left palpus. 350. (Nuevo León). 351. (Veracruz). 352-353. (Costa Rica). 354. (Panama). 355. Female genitalia, dorsal view (Panama). 356. Epigynum (Panama).

Figs. 357-359. *S. verus*, new species. 357-358. Carapace of male. 359. Palpus.

Figs. 360-362. *S. delicatulus,* new species. 360. Palpus. 361. Female genitalia, dorsal view. 362. Epigynum.

Figs. 363-364. *S. marxi* (Crosby), (Chiapas). 363. Female genitalia, dorsal view. 364. Epigynum.

Figs. 365-366. *S. expulsus* (Gertsch and Mulaik), (Cuba). 365. Female genitalia, dorsal view. 366. Epigynum.


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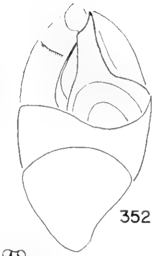
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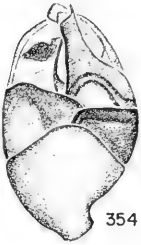
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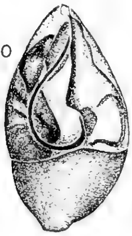
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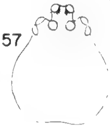
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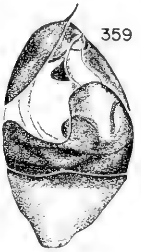
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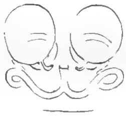
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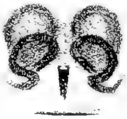
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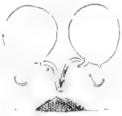
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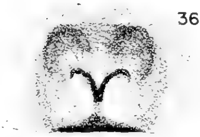
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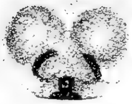
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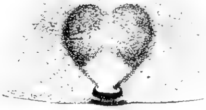
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Figs. 367-368. *Sphyrotinus chiapensis,* new species. 367. Female genitalia, dorsal view. 368. Epigynum.

Figs. 369-370. *S. boneti,* new species. 369. Female genitalia, dorsal view. 370. Epigynum.

Figs. 371-372. *S. bradti,* new species. 371. Female genitalia, dorsal view. 372. Epigynum.

Figs. 373-374. *S. corus,* new species. 373. Female genitalia, dorsal view. 374. Epigynum.

Figs. 375-376. *S. reservatus,* new species. 375. Female genitalia, dorsal view. 376. Epigynum.

Figs. 377-381. *S. indicatus* (Banks). 377. Female genitalia, dorsal view. 378. Epigynum. 379-380. Male carapace. 381. Left palpus.

Fig 382. *S. confraternus* (Banks), palpus.

Figs. 383-384. *S. orilla,* new species. 383. Palpus. 384. Male abdomen, lateral view.


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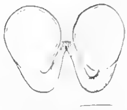
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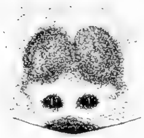
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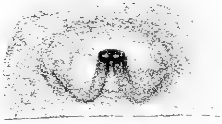
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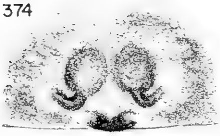

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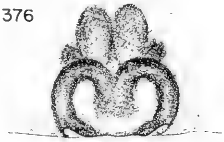

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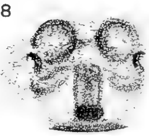

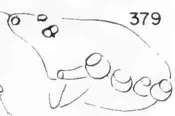
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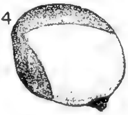


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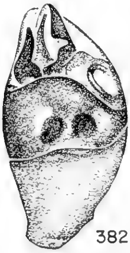
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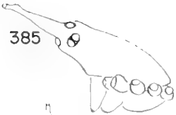
Figs. 385-389. *Sphyrotinus stylifrons* (Simon). 385-386. Male carapace. 387. Female genitalia, dorsal view. 388. Epigynum. 389. Left palpus.

Figs. 390-394. *S. piarco*, new species. 390. Female genitalia, dorsal view. 391. Epigynum. 392-393. Male carapace. 394. Palpus.

Figs. 395-397. *S. matachic*, new species. 395-396. Male carapace. 397. Palpus.

Figs. 398-400. *S. banksi* (Bryant). 398-399. Male carapace. 400. Palpus.

Figs. 401-403. *S. simla*, new species. 401-402. Male carapace. 403. Palpus.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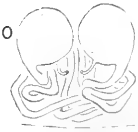
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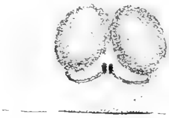
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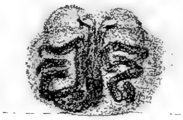
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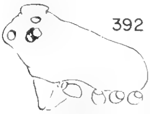
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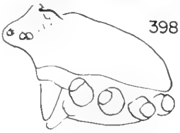
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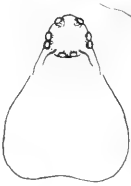
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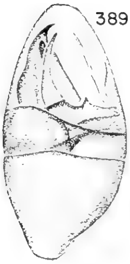
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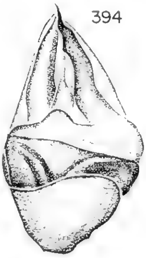
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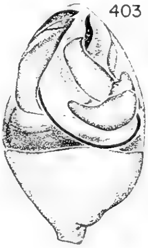
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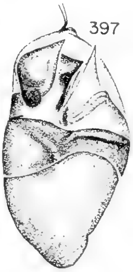
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Figs. 404-410. *Sphyrotinus insignis* (O. P. Cambridge). 404. Female genitalia, dorsal view. 405. Epigynum. 406-407. Male carapace. 408-410. Left palpus. 408. Mesal view, expanded. 409. Mesal view. 410. Ventral view.

Figs. 411-416. *S. notabilis*, new species. 411. Female genitalia, dorsal view. 412. Epigynum. 413-414. Male carapace. 415-416. Palpus. 415. Mesal view. 416. Ventral view.

Figs. 417-418. *S. bogus*, new species. 417. Female genitalia, dorsal view. 418. Epigynum.

Abbreviations: C, conductor; *E*, embolus; *M*, median apophysis; *R*, radix.


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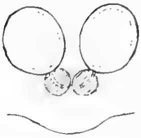
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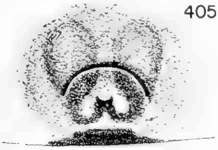
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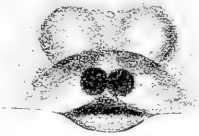
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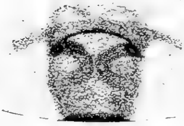
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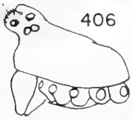
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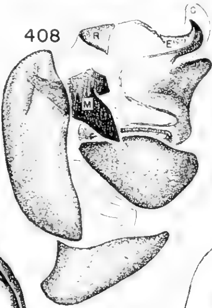
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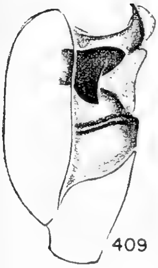
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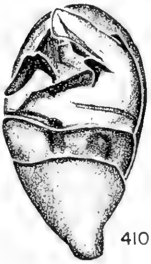
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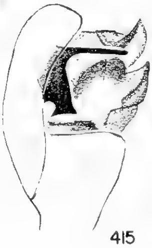
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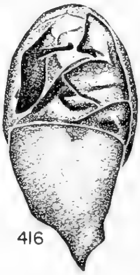
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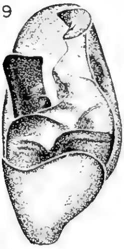

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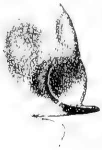

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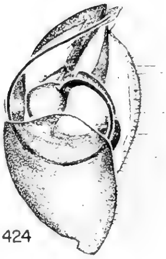

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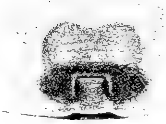

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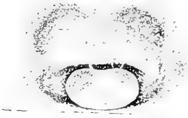

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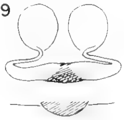

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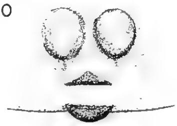

Bulletin of the Museum of Comparative Zoology
AT HARVARD COLLEGE
VOL. 121, NO. 4

THREE NEW GENERA AND ONE NEW SPECIES OF THE FAMILY GONOSTOMATIDAE

BY MARION GREY
Chicago Natural History Museum

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
JULY, 1959

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No. 4 — *Three New Genera and One New Species of the Family Gonostomatidae*

By Marion Grey
Chicago Natural History Museum

In the course of revising the family Gonostomatidae for a forthcoming volume on the Fishes of the Western North Atlantic, it was found necessary to create several new genera. And since it has been decided that descriptions of new genera and species should not be included in that monograph, we hasten to give such original descriptions in short papers which will antedate the larger work.

Two of the genera described below are based on previously known species. The third genus, hitherto unknown, is described from specimens trawled in 1957 aboard the U.S. Fish and Wildlife Service research vessel *Oregon.*

Figure 1 has been prepared by Mr. John Pfiffner, Staff Artist, Chicago Natural History Museum, and Figures 2 and 3 by Mrs. Myvanwy M. Dick, Museum of Comparative Zoology.

Terminology. The following symbols are used to represent the photophores: ORB, those situated close to the eye; OP, opercular photophores; SO, a pair often found near the symphysis of the lower jaw; BR, organs on the branchiostegal membranes; IV, pre-ventral photophores of the ventral series; VA, those of the ventral series found between the ventral bases and the anal origin; AC, photophores of the ventral series posterior to the anal origin; IC, total number in the ventral series, from tip of isthmus to base of caudal; OA, photophores of the lateral series. Photophore counts in parentheses indicate that these organs are grouped in a common gland.

POLLICHTHYS, new genus

Yarrella Jespersen and Tåning, 1919, Vidensk. Medd. Dansk Naturh. Foren., **70**:223; Norman, 1930, Discovery Rep., **2**:288 (part); Fowler, 1936, Bull. Amer. Mus. Nat. Hist., **70**:1202 (part); Lozano Rey, 1947, Mem. R. Acad. Cien. Madrid, Ser. Cien. Nat., **11**:171.

Type species: Yarrella mauli Poll.

Generic characters. Eye normal, moderate. Snout slightly longer than orbit. Interorbital width at center of eye about equal to or a little less than diameter of orbit. Mouth large, oblique; edge of premaxillary straight; toothed edge of maxillary curving downward from juncture with premaxillary, becoming almost straight posteriorly, nearly reaching preopercle. Premaxillary about half as long as toothed portion of maxillary. Angle of preopercle acute. Upper jaw with a single row of teeth, consisting of rather evenly spaced longer teeth and one or two smaller ones in each interspace, some of the interspace teeth curving inward. Teeth of lower jaw similar but smaller, and, anteriorly only, an outer row of very small teeth. Vomer toothless or with one or two small teeth on each side. Palatines each with a short row of small teeth. Pterygoids with or without a patch of very minute teeth on each side. Tongue usually with an irregular row of minute teeth centrally, not reaching tip. Gill rakers 11-12 + 4-5 on first arch. Spines on inner edge of first gill arch very short, a cluster of minute prickles below each one. No pseudobranchiae. Scales present but very deciduous. Anus closer to anal fin than to ventral bases, beneath fifth to seventh VA photophore. Head and trunk longer than tail. Dorsal origin about in middle of body length or slightly posterior to it. Anal origin beneath front or middle of dorsal fin. Ventral bases well ahead of dorsal origin. Adipose fin rather long-based, situated above a vertical from slightly behind middle of anal fin. ORB 2, one close to and below front margin of eye, the other beneath posterior margin of eye, the anterior one larger and apparently double, the posterior one similar in form to body photophores. OP 3, about equal in size, upper one level with upper edge of pupil, lower ones level with end of maxillary. SO present. BR 8. Body with two rows of photophores; photophores present on isthmus. IV 21-23, eighth and/or ninth slightly displaced. VA 7-9. AC 18-21, straight, four or five of them behind anal fin. IC 47-50. OA 19-21, reaching to a vertical from last one or two VA or first AC photophore. No other photophores, and no luminous tissue, on head or body as far as known. Fin rays: dorsal 10-12, anal 22-30, pectoral 8, ventral 6-7. Branchiostegal rays 11-12, no spines at bases. Vertebrae perhaps around 40 (count made on a faint X-ray photograph of one specimen).

Remarks. *Pollichthys* is probably most closely related to *Vinciguerria* Jordan and Evermann, from which it differs principally in having a longer and more forwardly placed anal fin. It is also similar to *Polymetme* McCulloch in some respects, and its dentition is rather like that of *Gonostoma* Rafinesque. It is not closely related to *Yarrella* Goode and Bean, with which it has been confused for many years. *Yarrella blackfordi* Goode and Bean has been found to possess serial photophores on the body above the IC and OA, arranged like those of *Lychnopoles argenteolus* Garman. And the genus *Yarrella*, of which *Lychnopoles* Garman is a synonym, contains only two species, *blackfordi* and *argenteola*.

The new genus has been named for Dr. Max Poll of the Musée Royale du Congo Belge, Tervuren, Belgium.

POLLICHTHYS MAULI (Poll)

Yarrella mauli Poll, 1953, Rés. Sci. Exp. Océanogr. Belge (1948-1949), vol. **4**, fasc. 2, pt. III, p. 59, fig. 24, (5°15′ S., 11°29′ E., 225-240 meters).

Yarrella blackfordi Jespersen and Tåning, 1919, Vidensk. Medd. Dansk Naturh. Foren, **70**:223, pl. 17, fig. 13; Breder, 1927, Bull. Bingham Oceanogr. Coll., **1**, (1), p. 18 (re-identified as *P. mauli* by Morrow, 1958, *in litt.*); Norman, 1930, Discovery Rep., **2**:288, fig. 7; Jespersen, 1933, Faune Ichth. Atl. Nord, **14**, fig.; Parr, 1934, Bull. Bingham Oceanogr. Coll., **4** (6), p. 5 (re-identified as *P. mauli* by Morrow, 1958, *in litt.*); Fowler, 1936, Bull. Amer. Mus. Nat. Hist., **70**:1203 (part), fig. 518; Beebe, 1937, Zoologica, **22**:201; Parr, 1937, Bull. Bingham Oceanogr. Coll., **3** (7), p. 45 (re-identified as *P. mauli* by Morrow, 1958, *in litt.*); Lozano Rey, 1947, Mem. R. Acad. Cien. Madrid, Ser. Cien. Nat., **11**:172, fig. 42; Grey, 1955, Fieldiana, Zool., **37**:272.

Specimens reported as *Yarrella blackfordi* by Marshall (1951, p. 3, and 1954, p. 204, fig. VIII, 10) probably belong to this species also.

The generic diagnosis has been based both on published descriptions and the following specimens, some of them hitherto unrecorded.

Bermuda, *Caryn:* Thirteen specimens, all somewhat shrunken since earlier measurements were made (Grey, 1955, p. 272). Haul 20, 400-450 meters, one, standard length 32 mm. Haul 22, 730-820 meters, three, 45-48.5 mm. Haul 23, 400-450 meters, two, 29.5-ca. 31.5 mm. Haul 25, 400-450 meters, one, 39 mm. Haul

26, 590-660 meters, two, 38 and ca. 45 mm. Haul 27, 1280-1370 meters, one, 34.5 mm. Haul 44, 400-450 meters, one, 38 mm. Haul 56, 260-275 meters, one, ca. 38 mm. Haul 62, 1000-1100 meters, one, 39 mm.

Bermuda: Five specimens, Stanford University No. 46475, recorded as *Yarrella blackfordi* by Beebe (1937, p. 201), Bermuda Oceanographic Expeditions, 1929-1930, of the New York Zoological Society. Net 861, 1280 meters, one, 16 mm. Net 867, 1463 meters, one, 20.5 mm. Net 888, 732 meters, one, 33.5 mm. Net 897, 1463 meters, one, ca. 12.5 mm. (but shrunken). Net 954, 1829 meters, one, ca. 13.5 mm. (but shrunken).

Bermuda: One specimen, U.S.N.M. No. 100537, 36 mm., *Grampus* (*Bache*) Station 10176, 32° 30′ N., 65° 48′ W., 5 February 1914, 750 meters.

Atlantic off Florida: One specimen, U.S.N.M. No. 100627, 39.5 mm., *Grampus* (*Bache*) Station 10202, 25° 34′ N., 79° 24′ W., 19 March 1914, 75 meters.

Atlantic off Florida: Fifteen specimens, ca. 16-37.5 mm., Miami University Marine Laboratory Collection, taken in plankton hauls made in ca. 25° N., 79° W., under the auspices of the National Geographic Society. Depth of capture 503 *or* 686 meters, one, front part of body only; 457 meters, one, standard length 25 or 26 mm.; 439-541 meters, one, 22 mm.; 212-366 meters, one, 24.5 mm.; 366 meters, one, metamorphosing, 17 mm.; 210 meters, one, 23.5 mm.; 155 meters, one, metamorphosing, 16-16.5 mm.; 137 meters, one, 26.5 mm.; 119 meters, one, 27.5 mm.; 110 meters, one, 17 mm.; 55 meters, one, 24 mm.; 29-66 meters, one, 22.5 mm.; 15 meters, one, 37.5 mm.; depth unknown, two, 17.5 and 36 mm.

Caribbean Sea: One specimen, U.S.N.M. No. 108281, ca. 37 mm., *Caroline,* off the Virgin Islands, 18° 35′ 30″ N., 65° 23′ 54″ W., 26 February 1933, 300 fathoms (549 meters).

Caribbean Sea off Nicaragua, *Oregon:* One specimen, ca. 44.5 mm., Station 1905, 12° 22′ N., 82° 27′ W., 11 September 1957, 275 fathoms (503 meters). One specimen, 45 mm., Station 1907, 12° 25′ N., 82° 23′ W., 11 September 1957, 400-425 fathoms (732-777 meters).

Western Pacific off eastern Negros, Philippines: Six specimens, 16.5-40 mm., *Albatross* Station 5190, 10° 8′ 15″ N., 123° 16′ 45″ E., 295 fathoms (540 meters).

P. mauli has not been found, so far, in the Gulf of Mexico, but is known from a large area in the North Atlantic west of 35° N. and south of 40° N., as well as off the African coast between 5° and 11° S. Although it has not previously been reported outside the Atlantic, the Chicago Natural History Museum collection contains six specimens from the Philippines, received in exchange from the United States National Museum.

The following counts have been made on Atlantic specimens: dorsal rays 10-12, anal rays 25-26, pectoral rays 8, ventral rays 6-7, branchiostegal rays 11-12, gill rakers on first arch 11-12 + 5. The photophores are small but conspicuous: BR 8; IV 22, eighth and/or ninth slightly elevated; VA 7-9, scarcely separable from AC; AC 18-20, four or five of them behind anal fin; IC 49-50; OA 19-21, reaching a vertical from the next-to-last VA, the last VA, or the first AC photophore.

Individual variation is rather slight and it is interesting that specimens from the Pacific differ very little from Atlantic specimens. The largest of these, 40 mm. in standard length, has a slightly greater depth and more posterior insertion of the dorsal fin, lacks the vomerine and pterygoid teeth, and has only 47 photophores in the ventral row (IC), but is otherwise indistinguishable from Atlantic specimens. Of the smaller examples, 16.5-26 mm. in standard length, four also have an IC count of 47, and in the fifth it is 48. Counts of the largest Philippine specimen are as follows: dorsal rays ca. 10, anal rays ca. 24, branchiostegal rays 11 or 12, gill rakers on first arch 11 + 4. Photophores: BR 8; IV 21, the eighth and tenth slightly below, and the ninth slightly above, the level of the first seven; VA 7; AC 19, five of them behind the anal fin; IC 47; OA 21, reaching a vertical from the first AC photophore.

The following measurements are expressed in per cent of the standard length, 40 mm., and are followed in parentheses by similar measurements of nine western Atlantic specimens, whose standard lengths are 37.5-48.5 mm. Depth 15.0 (11.9-14.5); head 23.8 (20.6-ca. 24.4); snout ca. 5.0 (5.1-5.55); orbit ca. 3.75 (2.56-4.45); interorbital width at center of eye ca. 2.5 (2.22-3.33); upper jaw 16.2 (15.4-17.9); premaxillary 5.0 (5.12-6.4); toothed edge of maxillary 11.2 (10.0-11.5); tip of snout to dorsal origin 52.5 (49.3-51.5), to anal origin 55.0 (53.3-56.6), to ventral bases

41.5 (ca. 39.0-43.3); distance between anal origin and base of middle caudal rays 42.5 (41.0-44.7), last anal ray and base of middle caudal rays 11.2 (10.2-13.1), last dorsal ray and base of middle caudal rays 33.8 (ca. 33.3-37.1), last dorsal ray and adipose fin 13.7 (12.8-15.8), ventral bases and anal origin ca. 12.5 (13.3-15.4); least depth of caudal peduncle 3.75 (3.1-4.45); dorsal base ca. 8.75-10.0 (10.2-12.4); anal base ca. 31.2 (ca. 28.9-ca. 31.6).

Metamorphosing specimens. Postlarval stages of *P. mauli* have not yet been described, but among the young fishes in the collection of the Miami University Marine Laboratory are two metamorphosing specimens. The younger of these is about 17 mm. in standard length. It is somewhat more slender than the older fish, which is 16-16.5 mm. in standard length; and it has the anal insertion farther back on the body, beneath the end of the dorsal fin. The posterior position of the anal fin might have prevented positive identification if the older specimen had not been at hand for comparison. The two little fishes obviously belong to the same species and it can only be assumed that during metamorphosis the body shrinks in length between the ventral bases and the anal origin, resulting in a more anterior insertion of the anal fin. This shrinkage undoubtedly occurs just in front of the anal fin, which, in the younger postlarva, is separated by a short gap from the last VA photophore.

In appearance, the two postlarvae from Florida are similar to metamorphosis stages of *Vinciguerria.* They differ most noticeably in the complete absence of pigment at the end of the caudal peduncle, and in having a longer tail and longer anal fin. The development of *Pollichthys* probably more or less parallels that of *Vinciguerria* in 1) having the photophores mostly formed, but unpigmented, prior to metamorphosis; 2) having most of the photophores pigmented simultaneously; 3) a rather sudden transition from the postlarval stage to the metamorphosis stage; and 4) the changes in body proportions proceeding rapidly toward the adult form. The smallest metamorphosed specimen known was 16 mm. in standard length (Jespersen and Táning, 1919, p. 223). It was not described. The smallest adolescents seen from the western Atlantic (off Florida) are 17 and 17.5 mm. in standard length and differ from adults only in having a more slender body, less dorsal pigment, and only 14-15 OA photophores. Some of the more posterior OA and middle AC photophores are not fully developed on these little fishes, and even in specimens as large as 26-27 mm. the most posterior OA organs are still not fully developed.

The SO must appear quite early in this species as it is present in all adolescent specimens seen, including four from the Philippines. As in *Vinciguerria* it is the OA photophores that are last to develop, the full complement not being acquired until a standard length of 23-24 mm. has been reached. The number of OA on small Atlantic specimens is 14-15 at a length of 17 and 17.5 mm., 17-18 at a length of 22-23.5 mm. In the small Philippine specimens counts are 12 at 16.5 mm., 14 at 18 mm., 13 and 16 at 20 mm.

Description of younger metamorphosing specimen, standard length ca. 17 mm.: Eye oval shaped. Dorsal rays 10 or 11. Anal rays uncertain, at least 22 or 23, origin of anal beneath last dorsal rays. Pectorals small, pedunculate. Ventrals very small, membranous. Adipose fin long-based, well developed. Ventral finfold present on posterior half of distance between ventrals and anal. End of gut slightly protruding just in front of anal fin. Photophores on head: ORB 2, situated as in adult; lower posterior OP; BR 8; IV, 6 on isthmus, 13 from just in front of pectoral base to ventral base, the two groups separated by a short space in which one unpigmented organ is barely discernible. VA 9, the last two small, ending a short distance in front of anal origin. AC small and faintly pigmented above anal fin, 9 on left side, 11 on right side, the last two scarcely pigmented: and 2 larger ones on caudal peduncle. OA, 3 on left side, 1 on right side, faintly pigmented. Head and body entirely without pigment excepting the brown photophores; end of caudal peduncle transparent.

Description of older metamorphosing specimen, standard length ca. 16-16.5 mm.: Eye round. Dorsal rays 10. Anal rays uncertain, more than 20, origin of anal fin beneath fifth dorsal ray. Pectorals short, not pedunculate. Ventrals short, with rays developed. Adipose fin long-based, well developed. End of gut slightly protruding, anus below space between seventh and eighth VA photophore. Photophores on head: ORB 2; OP 3, the lower posterior the largest, the lower anterior and upper ones small and lighter in color; BR 8, IV 22, the ninth slightly elevated. VA 8, not separated from anal origin or from AC. AC 18, the fifteenth poorly developed, the two or three preceding it very small, and the last three well developed. OA 5. Head without pigment except on photophores (brown). Body mostly colorless but with a streak of black internal abdominal pigment and very faint indications of the internal spots along base of anal fin.

WOODSIA, new genus

Type species. Photichthys nonsuchae Beebe, 1932.

Generic characters. Eye normal, large. Snout shorter than orbit. Interorbital width at center of eye less than diameter of orbit. Mouth large, oblique; edges of premaxillary and maxillary straight; maxillary reaching well past eye but not quite to edge of preopercle. Premaxillary more than half as long as toothed portion of maxillary. Angle of preopercle slightly acute. Teeth of upper jaw uniserial, larger on premaxillary than on maxillary, a few minute teeth between larger ones. Lower jaw with a series of widely spaced teeth, a few small interspace teeth and, anteriorly only, an outer row of a few widely spaced smaller teeth. Vomer toothless or with two rudimentary teeth. Palatines each with a long row of curved teeth decreasing in size posteriorly. No teeth on pterygoids or tongue. Gill rakers 2-4 at angle, minutely denticulate, otherwise represented only by short, smooth spines. Spines on inner edge of first gill arch short. No pseudobranchiae. Anus close to anal fin. Head and trunk more than twice as long as tail. Origin of dorsal fin behind middle of body length. Origin of anal fin well behind end of dorsal fin. Ventral bases slightly in front of dorsal origin. Adipose fin well developed, above middle of anal fin. ORB 2, one close to front margin of eye, the other close to its posterior margin, the anterior one a little larger. OP 3, upper one slightly below a level from top of eye; lower anterior one about level with end of maxillary and smaller than either the upper one or the lower posterior one; the latter placed a little higher than the anterior lower organ. SO present, large. BR 14. No additional photophores on head. Body with two rows of photophores; photophores present on isthmus. IV 8 + 3 + 14 = 25, the first eight straight, the next three smaller and in an ascending cross line, the ninth being slightly below the eighth; and the last fourteen straight and on a level with the ninth (thus slightly lower than the first eight). VA 11-12. AC 12, straight, five or six of them behind anal fin. IC 48-49. OA 29-31, extending to, or nearly to end of anal fin. No additional photophores and no luminous tissue on body as far as known. Fin rays: dorsal 12, anal 14, pectoral 9-10, ventral 7-8. Branchiostegal rays 17, no spines at bases.

Remarks. *Woodsia* is closely related to *Photichthys* Hutton and, more remotely, to *Vinciguerria* Jordan and Evermann and *Ichthyococcus* Bonaparte. The structure of the photophores is similar in all of these genera and they also share such characters as two suborbital photophores, similar positions of the dorsal and anal fins, and a short tail. *Photichthys* and *Woodsia* are alike in their dentition, in having a longer premaxillary than other related genera, and a larger number of branchiostegal rays and BR photophores. The new genus differs from all gonostomatids in having the gill rakers reduced in number, and from *Photichthys* it differs further in the shorter anal fin, the deeper body form, and lower photophore counts.

The new genus has been named for Mr. Loren P. Woods, Curator of Fishes, Chicago Natural History Museum.

WOODSIA NONSUCHAE (Beebe)

Figure 1.

Photichthys nonsuchae Beebe, 1932, Zoologica, **13**:61, fig. 11; 1937, *op. cit.*, **22**:201.

Measurements and other information about the holotype of this species, U.S.N.M. No. 170938, have been obtained through the kindness of Dr. Giles W. Mead; and to Dr. Alfred W. Ebeling and Dr. Carl L. Hubbs I owe the opportunity of studying a specimen from the Gulf of Panama, Scripps Institution of Oceanography No. SIO-55-244, standard length 76.5 mm. It was taken in 730-0 fathoms (1335-0 meters), 14 November 1955, 4° 04′ N., 78° 43′ W. The following description is based on the Pacific specimen.

Dorsal rays 12, anal rays 14, pectoral rays 10, ventral rays 8, branchiostegal rays 17.

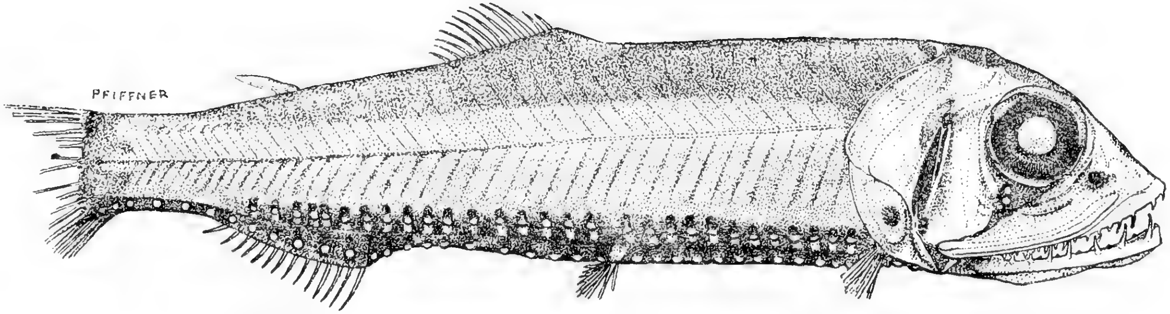

Fig. 1. *Woodsia nonsuchae* (Beebe). Scripps Institution of Oceanography No. S10-55-244, standard length 76.5 mm., Gulf of Panama.

Measurements in millimeters: depth 15.5; head ca. 23; snout ca. 5.5; orbit ca. 7.5; interorbital width at center of eye ca. 5; upper jaw 16; premaxillary 7.5; toothed portion of maxillary 8.5; lower jaw 17; tip of snout to dorsal origin 43.5, to anal origin ca. 56, to ventral base 39.5; distance between anal origin and base of middle caudal rays 20.5, last anal ray and base of middle caudal rays 11, last dorsal ray and base of middle caudal rays 26.5, last dorsal ray and adipose fin 11, ventral base and anal origin 17; least depth of caudal peduncle 7; dorsal base 8; anal base 10.5; pectorals and ventrals broken.

Scales and most of skin lost. Bones of head fragile, jaws and snout somewhat damaged. Gill rakers on first arch developed only at angle, two on left side, three on right side; otherwise represented by 3-4 very short, smooth spines on upper limb and 11 clusters of two or three little spines on lower limb; total count of gill rakers and rudiments 13 + 4 on left side, 13 + 3 on right side.

Premaxillary with a single row of six slender, widely spaced teeth, curving slightly inward, the first and last of these smaller; sometimes a few minute teeth in interspaces. Maxillary with a single row of about ten smaller teeth, and a few minute teeth in each interspace. Lower jaw with a series of seven to nine widely spaced slender teeth, most of them as long as the longest premaxillary teeth; a few sparse, smaller interspace teeth; and anteriorly only, an outer row of four widely spaced teeth, smaller than those of inner row. Vomer toothless. Each palatine with a row of about eleven widely spaced, curved teeth, the posterior ones minute. Pterygoids and tongue without teeth.

Photophores conspicuous, many of them "double," the upper black-sheathed portion enlarged and, in some cases (especially on the head) apparently with an exposed luminous area; this double aspect particularly noticeable in the ORB, SO, BR, OP, AC, OA and the pre-pectoral IV. BR 14. IV 8 + 3 + 14 = 25. VA 11. AC 12, five of them behind anal fin, the last three smaller and slightly separated from the rest. OA 29, the last four quite small, ending above the twelfth anal ray.

Myomere count probably about 45.

A series of pores along lateral line area anteriorly; and on sides from behind head to anal origin smaller pores, which follow the lines of the septa between the muscle bands, both above and below the lateral line.

Other characters as in generic diagnosis.

Color probably brown or black, judging from remains of skin. Linings of mouth and gill covers dusky. Adipose fin blackish.

Remarks. The newly discovered Pacific specimen differs remarkably little from the holotype, which was caught off Bermuda at a depth of 1097 meters. Dr. Giles W. Mead has examined the latter, and percentages based on his measurements are shown in the table. The most important correction of the original description is the length of the premaxillary, which, in the figure of the type, was shown to be less than half as long as the toothed portion of the maxillary. Actually it extends to a vertical from the anterior edge of the pupil and bears eight longer teeth (on each side). Dr. Mead has also confirmed the presence of the SO and upper OP photophores. As shown in the table, the Pacific specimen differs in counts from the holotype only in having one more ventral ray, one more pectoral ray, one less VA and two less OA photophores. The two specimens are almost identical proportionately with one notable exception, i.e., the lengths of trunk and tail. The Atlantic fish has a longer trunk and shorter tail, the insertion of the anal fin being farther behind the end of the dorsal fin than in the Pacific specimen, and the distance between the ventral bases and the anal origin is also a little longer. If future material should prove this difference to be invariable, the Pacific form would probably require a new specific name, but in view of the fact that the two specimens are otherwise so similar, they are for the present considered to belong to a single species, *nonsuchae.*

Table. Counts and measurements of *Woodsia nonsuchae* taken from the literature where indicated.

	Beebe, 1932, p. 61	U.S.N.M. 170938 (Mead, 1958, *in litt.*)	SIO-55-244
Standard length	89	ca. 85.4	76.5
Dorsal rays	12	12	12
Anal rays	14	14	14
Pectoral rays	9	9	10
Ventral rays	7	7	8

	Beebe, 1932, p. 61	U.S.N.M. 170938 (Mead, 1958, *in litt.*)	SIO-55-244
Branchiostegal rays	—	16?	17
Gill rakers on first arch	4	—	2-3
Total number of gill rakers and rudiments	13+5	—	13+3-4
ORB	2	2	2
OP	—	3	3
SO	—	+	+
BR	14	—	14
IV	11+14=25	—	8+3+14=25
VA	12	—	11
AC	12	—	12
IC	49	—	48
OA	31	—	29
Long teeth in upper jaw	19	—	16
Long teeth in lower jaw	10	—	7-9
Vomerine teeth	2 rudiments	—	0
Palatine teeth	11	—	11
	per cent of standard length		
Depth	20.2	20.5	20.2
Head	29.8	30.4	ca. 30.0
Snout	7.3	6.4[1]	ca. 7.2
Orbit	9.0	10.5	ca. 9.8
Interorbital width at center of eye	5.05	7.6	ca. 6.54
Upper jaw	—	21.0	21.0
Premaxillary	—	ca. 9.36	9.8
Toothed portion of maxillary	—	12.3	11.1
Lower jaw	20.8	ca. 21.6	22.2
Tip of snout to:			
dorsal origin	—	ca. 57.4	57.0
anal origin	—	76.7	ca. 73.4
ventral base	—	51.5	51.6
Distance between:			
anal origin and caudal base	—	25.5	26.8
end of anal and caudal base	—	13.45	14.4

---

[1] Snout now in poor condition.

	Beebe, 1932, p. 61	U.S.N.M. 170938 (Mead, 1958, *in litt*)	SIO-55-244
	per cent of standard length		
end of dorsal and caudal base	—	33.4	34.6
end of dorsal and adipose	—	13.45	14.4
ventral base and anal origin	—	25.8	22.2
Least depth of caudal peduncle	8.43	8.9	9.15
Dorsal base	—	9.37	10.45
Anal base	—	14.0	13.7

SONODA, new genus

Type species. Sonoda megalophthalma, new species.

Generic characters. Eye normal, very large. Snout shorter than orbit. Interorbital width at center of eye much less than diameter of orbit. Mouth moderate, almost vertical; edge of premaxillary slightly concave or nearly straight; toothed edge of maxillary convex, not quite reaching a vertical from posterior margin of pupil. Premaxillary shorter than toothed portion of maxillary but more than half its length. Angle of preopercle vertical. Teeth minute, uniserial in upper jaw, in two or more rows anteriorly in lower jaw. Vomer with three or four small teeth on each side. Palatines with a single row of minute teeth. Pterygoids and tongue probably toothless. Gill rakers 15-18 + 3 on first arch. No spines on inner edge of first gill arch except sometimes a single minute one on upper limb; second arch with one or two clusters of minute spines. Pseudobranchiae sometimes present, small. Scales present, deciduous. Head and trunk slightly shorter than tail. Anus close to ventral bases. Dorsal origin slightly nearer snout than base of caudal. Anal in two sections, connected by membrane, its origin beneath or slightly in advance of first dorsal ray. Ventral bases well ahead of dorsal origin. No adipose fin. ORB 1, in front of lower portion of eye. OP 3, upper one close to eye and level with middle of eye; lower anterior one at end of maxillary; lower posterior one vertically elongate, in a black sheath with luminous areas showing above and below (probably double). SO absent. BR usually (6), (7) on one side of one specimen. Body with two rows of serial photophores; photophores present on isthmus. IV (6) + (10); the first six larger; the fourth, fifth and sixth curving upward toward pectoral base; the last ten close together and separated from those on the other side only by two black bands on belly. VA (7) or (8), joined above to a common gland. AC in two long groups, (16-21) + (19-24) = 36-43, the organs small, separated below but joined above to narrow glands; the first group commencing over seventh or eighth anal ray, second group commencing above last anal ray. IC 59-67. OA (2) + 4-5 = 6-7, the first two joined above to a gland, others separate. No additional photophores or patches of luminous tissue on head or body as far as known. Fin rays: dorsal 8-9; anal 8-9 + 14-16 = 22-25, the first eight or nine rays thicker than the rest and separated from them by a short but definite space, although connected by a relatively thick membrane; pectoral 13-15; ventral 6. Branchiostegal rays 8, no spines at bases. Vertebrae 40 including hypural, counted on an X-ray photograph of one specimen.

Remarks. *Sonoda* is in some respects intermediate between *Maurolicus* Cocco and *Valenciennellus* Jordan and Evermann. It is similar to the latter in the relative positions of the dorsal, anal and ventral fins, in having the trunk shorter than the tail, and in lacking the SO. In the arrangement of the AC photophores the new genus is closer to *Maurolicus* and there is at least a superficial similarity in the shape of the anal fin in these two genera also. However, in *Maurolicus* the anal fin does not seem to be actually in two separated sections as it is in *Sonoda*. The lower posterior OP, and some of the IC photophores, are similar in structure to those of *Argyripnus* Gilbert and Cramer. In having 7-8 VA photophores *Sonoda* differs from all other known maurolicid genera, in which these number only 4-6.

The new genus is named for Miss Pearl Sonoda, Assistant in the Division of Fishes, Chicago Natural History Museum.

SONODA MEGALOPHTHALMA, new species

Figures 2, 3

Holotype. Standard length 58 mm., *Oregon* Station 1918, 13° 25′ N., 82° 01′ W., 12 September 1957, 300 fathoms (548 meters).

Paratypes.

Two specimens, standard lengths 54-55 mm., taken with the holotype.

One specimen, 43.5 mm., *Oregon* Station 1924, 12° 50′ N., 82° 12′ W., 13 September 1957, 275 fathoms (503 meters).

Four specimens, ca. 50-60 mm., *Oregon* Station 1928, 13° 14′ N., 82° 06′ W., 12 September 1957, 300 fathoms (548 meters).

Five specimens, 44.5-52.5 mm., *Oregon* Station 1931, 13° 56′ N., 81° 50′ W., 14 September 1957, 275 fathoms (503 meters).

Eleven specimens, 48.5-58 mm., *Oregon* Station 1933, 14° 08′ N., 81° 49′ W., 14 September 1957, 300 fathoms (548 meters).

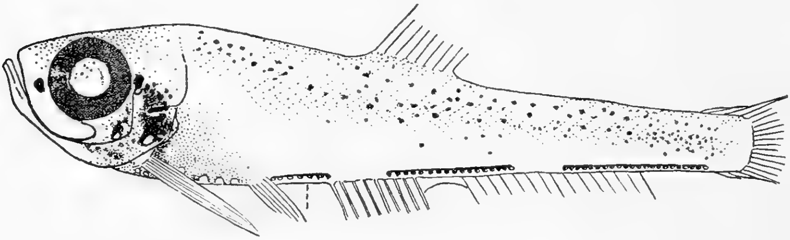

Fig. 2. *Sonoda megalophthalma* n.sp. Holotype, standard length 58 mm., *Oregon* Station 1918, Caribbean Sea.

Description. Dorsal rays 8-9 (holotype, 9); anal rays 8-9 + 14-16 = 22-25 (holotype 9 + 15 = 24); pectoral rays 13-15 (holotype 14); ventral rays 6; branchiostegal rays 8; gill rakers on first arch 15-18 + 3, counted on four specimens (holotype 16 + 3); pyloric caecae 6; vertebrae 40, including hypural, counted on holotype only.

Measurements of the holotype in millimeters: standard length 58, greatest depth 12, length of head 14.5, snout 3, diameter of orbit 6.5, interorbital width at center of eye ca. 2, upper jaw ca. 9. Tip of snout to dorsal origin 26, to anal origin 25.5, to ventral bases ca. 20. Distance between anal origin and base of middle caudal rays 32.5, last anal ray and base of middle caudal rays 10, last dorsal ray and base of middle caudal rays 24. Least depth of caudal peduncle 5. Dorsal base 6. Anal base 23. Length of pectoral fin 11, of ventral fin ca. 5.

Measurements expressed in per cent of standard length, of nineteen specimens, standard length 43.5-60 mm.: depth 19.0-21.8; head ca. 23.4-25.7 (and one, 27.3); snout 4.5-6.36; orbit 10.3-12.1; interorbital width at center of eye 2.19-3.54; upper jaw 15.0-16.4; tip of snout to dorsal origin 43.0-47.7, to anal origin 41.0-46.6, to ventral bases ca. 32.4-38.2; distance between first anal ray and base of middle caudal rays 54.0-57.6, last anal ray and base of middle caudal rays 15.2-19.1, last dorsal ray and base of middle caudal rays 37.1-45.4; least depth of caudal peduncle ca. 7.0-9.25; dorsal base 8.6-11.0; anal base ca. 36.4-41.4; pectoral length 17.0-24.1; ventral length ca. 6.9-11.3.

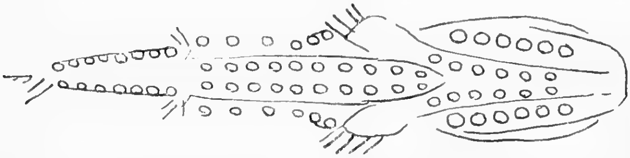

Fig. 3. *Sonoda megalophthalma* n.sp. Diagrammatic ventral view of anterior portion of body, showing position of light organs.

Bones and skin of head very fragile, nostrils not apparent except on one specimen, in which they appear to be placed high on snout as in other gonostomatid fishes. Pseudobranchiae small, found on only a few specimens, perhaps lost in others because of their fragility. Skin of abdomen thin, often damaged. A large, thin, cycloid scale present beneath pectoral of one specimen from St. 1933, no scale pockets visible, extent of scalation unknown. Fin rays fragile, mostly broken, probably normally all rather long, judging from remnants. Pectoral in some specimens reaching first or second anal ray. Ventrals, when complete, reaching anal origin.

Photophores of BR, IV and OA series relatively large, the VA, and especially the AC, smaller. Total number of IV organs always 16, those of BR 6 except in one specimen, which has 6 on one side, 7 on the other. Number of VA and AC organs variable, the former 7 in twelve specimens, 8 in eight specimens and 7/8 in two specimens; those of AC often differing on the two sides of a single specimen. OA variable but usually 6. Fin rays also varying in number: dorsal 9 in nineteen specimens, 8 in four specimens; first group of anal rays 9 in twenty specimens, 8 in two specimens; second group of anal rays 15 in ten specimens, 16 in seven specimens, 14 in one specimen; total number of anal rays 24 in ten specimens, 25 in six specimens, 22 in one specimen; pectoral rays 14 in twelve specimens, 15 in three specimens, and 13 in two specimens; ventral rays always 6.

Color in alcohol: body largely pale yellowish or whitish, sprinkled with black chromatophores; abdomen black, sometimes with bluish or greenish iridescence anteriorly. Opercles and lower part of head black. Snout, lower jaw and top of head colorless and transparent. A yellowish body visible beneath top of head between and behind eyes. Fins colorless. Inside of mouth colorless. Linings of gill chamber and peritoneum black.

At least five specimens are mature females.

Characters otherwise as in generic diagnosis.

LITERATURE CITED

BEEBE, W.

1932. Nineteen new species and four post-larval deep-sea fish. Zoologica, **13**:47-107, figs. 8-31.

1937. Preliminary list of Bermuda deep-sea fish. Zoologica, **22**:197-208.

GREY, M.

1955. Notes on a collection of Bermuda deep sea fishes. Fieldiana, Zool., **37**:265-302, figs. 45-56.

MARSHALL, N. B.

1951. Bathypelagic fishes as sound scatterers in the ocean. Jour. Mar. Res., **10**:1-17.

1954. Aspects of deep sea biology. London. 380 pp., 4pls., text figs.

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THE ANOLES OF THE EASTERN CARIBBEAN (SAURIA, IGUANIDAE)

Parts I-III

By
JULIAN S. KENNY
VICTOR C. QUESNEL
GARTH UNDERWOOD
ERNEST E. WILLIAMS

WITH ONE PLATE

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
JULY, 1959

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No. 5 — *The Anoles of the Eastern Caribbean (Sauria, Iguanidae)*. Parts I-III

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Part I. Preface

By Ernest E. Williams

The papers that follow have resulted from an attempt, some years ago, to survey what was felt to be the simplest geographic segment of the genus *Anolis*. This study was intended as the first part of a projected general review of this very large and complex genus.

The Lesser Antillean islands (defined as the islands from Anguilla to Grenada) had, so far as was definitely known, no more than two species of anoles on any one island, and a preliminary survey of material in the Museum of Comparative Zoology seemed to indicate that no more than five full species were involved, all rather similar but still differing in clear and simple morphological details one from another. It seemed also from this survey, as carried out by myself (and also independently for his own information by my co-worker Benjamin Shreve), that no major taxonomic problems existed and that the analysis at this level could be carried to completion simply and routinely.

However, it had been my experience while studying the anoles of Jamaica, in collaboration with Garth Underwood, that colors in life enormously assisted in the recognition of forms that morphologically were often disconcertingly close. I therefore asked Garth Underwood, who was visiting the Lesser Antilles in

1956 for other purposes, to send me a few live anoles from each of the islands at which he stopped. This he faithfully did.

The material that he collected very soon destroyed the pretty simplicity that had been fancied to exist; the problems that he presented us with are still only partially solved, although Garth Underwood himself has since studied the types of Lesser Antillean *Anolis* in the Paris Museum, in the British Museum, and in the United States National Museum, and although he and I and Benjamin Shreve have restudied all the Museum of Comparative Zoology specimens, increased as they have been by Underwood's own collections.

Prominent in the new emerging picture are certain new or rediscovered ''sibling'' forms. A supposedly unitary series of forms on the southern Lesser Antilles resolves itself on closer inspection into geographically replacing forms of at least two species somewhat erratically distributed over these islands.

The species we here call ''sibling'' can, it is discovered by close examination, be recognized and defined on conventional morphological characters. However, it is very probable that the rather subtle scale characters that distinguish them would have been dismissed — in the past have been dismissed — as ''variation'' had these species not first been recognized by color or behavior or both.

It will be recalled that the segment of *Anolis* that is here reported on was believed to be, and may well be, the simplest areal segment of the genus in which more than one species occurs. (Only the portion of the southeastern United States in which *A. carolinensis* is the only member of the genus can be simpler.) Yet we have found the complications formidable and not amenable to study on the basis of preserved specimens alone.

It is even more evident in this genus than in others that we cannot be prisoners of our conventional museum techniques, that a very wide approach will barely encompass the things we need to know. Knowledge of the live animals is needed — of captives, if necessary — but preferably field knowledge. *Anolis* must be known intimately — anatomically, ecologically, ethologically — in all its relationships within and between species, if the many puzzles the genus poses are to be solved.

How remote from this ideal our present knowledge is, anyone with even a little familiarity with the genus is aware. Many forms are known from single specimens — rarely with any notes on color in life, much less on habits and habitat. Even the West Indian anoles, which often swarm wherever they are to be found, are extremely poorly documented ecologically and ethologically.

It is thus no accident that the study of which we here publish a first portion has been a cooperative effort. It has required special opportunities, much travel, and a great deal of work to produce what is transparently a bare beginning. One new form is described here by Underwood. Some evidence is already at hand that other new forms require to be described. Further parts of this study will deal with these new forms and with other data still accumulating.

Part II. Two Sibling Species of Anoles in Trinidad

By Victor C. Quesnel and Julian S. Kenny

Two species of *Anolis* lizards have been recorded from Trinidad by Parker, 1935: *Anolis chrysolepis* and *Anolis aeneus*. In 1955 it came to our notice that there was an apparently different, third, species which had not been recorded. A specimen was sent to the British Museum (Nat. Hist.) where it was identified as *Anolis aeneus*. This specimen, when alive, was predominantly green in color, whereas the lizard that we knew as *A. aeneus* is predominantly grey. A specimen of the grey form sent with the green one to the British Museum (Nat. Hist.) was also identified as *A. aeneus*. We believe that these two forms of *A. aeneus* may be, in fact, distinct species, and we give below our observations bearing on this point.

The lizards are similar in squamation and limb measurements, and preserved specimens tend in time to assume the same color. Yet, in the field, the grey form appears the larger and more heavily-built and there is a suggestion of slight differences in the shape of the head.

From the measurements we have so far been able to make, we would say that eggs and newly-hatched young are similar in size. Thus, seven eggs of the grey form ranged from 9.5 x 6.9 mm to 11.0 x 9.0 mm, and two eggs of the green form measured 10.7 x 5.8 mm and 10.3 x 8.0 mm. The eggs increase in size during incubation so that large numbers of eggs of known ages would be necessary for the detection of any differences there may be.

Similarly, four newly-emerged young of the grey form had the following measurements (snout to vent + tail): 20.5 + 36.5 mm; 21.8 + 40.0 mm; 20.7 + 37.3 mm; 20.5 + 35.5 mm; and one of the green form measured 19.5 + 33.0 mm.

In spite of these general similarities we believe that the two forms are really distinct species. The differences in coloration and pattern of the living animals are striking. The grey form has a pattern of forward-pointing V-shaped cross bands, usually brown in color, and is frequently speckled, mottled or marbled. There is a great deal of variation between individuals and in the same individual at different times. The green form shows hardly any sign of V-shaped markings. The general body color is green-gold, rather paler in the mid-dorsal line than dorso-laterally, fading to a pure lemon yellow on the underparts. The head is brilliant green and the area surrounding the eye bright blue. This lizard can change its color to rich red-brown, and this is the color of the newly-hatched young. The dark coloration which the grey form sometimes assumes is also brown, but without the reddish tinge.

There is a marked behavioral difference which we have confirmed many times. The green form will frequently enter houses and make itself at home there; the grey form will not. In almost four years of living in a house whose garden is overrun with the grey *Anolis*, V. C. Quesnel has never yet found one in the house. On the other hand, we have had several reports of lizards entering houses and on each occasion careful questioning and a check of the garden showed that the lizard concerned was the green *Anolis*. One informant related how the lizards lived in and around the furniture and took crumbs from the floor near the dining table. The specimen of the green form which was sent to the British Museum (Nat. Hist.) was caught inside a house. On one occasion some lizards of both forms escaped from a cage in the home of J. S. Kenny and the next day one or two of the green form were recaptured in the house; the grey ones had disappeared.

So far, we have found the grey form in Port of Spain, Mayaro, and St. Augustine and the green form in Port of Spain, St. Augustine, San Fernando and Usine, Ste. Madeleine, but in districts where they both occur they are seldom found together. We have found only two mixed populations, and in these one glance is usually enough to classify an individual as grey or green. Only one large male in one of these populations seemed to be intermediate in color. Their habitat preferences appear to be similar. In Port of Spain both abound in hedges and low shrubs. This is in contrast with Beebe's observations of the grey form in British Guiana. (It is clear from his description that it is the grey form he observed.) Beebe (1944) says: ''The Marbled Anolis is a tree-trunk lizard like *Plica*, rather than a frequenter of low, leafy shrubs.'' Perhaps it is the near identity of ecological niche that accounts for the usual absence of mixture of populations of the two forms in Trinidad; or perhaps there are differences in preferred habitats that we have not detected.

These observations show the necessity for a thorough study of the anatomy and behavior of the two forms in order to substantiate or reject our view that they are distinct species.

REFERENCES

BEEBE, W.
1944. Field Notes on the lizards of Kartabo, British Guiana and Caripito, Venezuela. Part 2. Iguanidae. Zoologica, **29**: 195-216.

PARKER, H. W.
1935. The lizards of Trinidad. Tropical Agriculture, **12**: 65-70.

Part III. Revisionary Notes

BY GARTH UNDERWOOD
Department of Zoology, University College of the West Indies

I became involved in the problems of the anoles of the eastern Caribbean through a combination of circumstances. In the summer of 1956 I visited Trinidad and Tobago travelling on a ship which called at St. Kitts, Antigua, Montserrat, Dominica, St. Lucia, Barbados, St. Vincent and Grenada. On each of these islands I collected anoles and sent living material to the Museum of Comparative Zoology to assist the studies of Dr. E. E. Williams and Mr. B. Shreve. What was intended to be purely routine collecting revealed problems which were not apparent from the study of preserved material. The following summer I travelled on study leave and was able to visit the Museum d'Histoire Naturelle in Paris (M.H.N.P.), the British Museum of Natural History (B.M.N.H.), the Museum of Comparative Zoology (M.C.Z.) and the United States National Museum (U.S.N.M.). I have thus seen living material from ten different islands, preserved material of all the forms and all of the type specimens, save three. For comparison with the types in Europe Dr. Williams sent me specimens from the French islands of Guadeloupe, Désirade, Marie Galante and Martinique. As I had made my collections, examined material and arrived at conclusions before having an opportunity to consult personally with the other two interested parties it seemed better that I should assume personal responsibility for my findings. Messrs. Williams and Shreve, however, very generously went further and invited me to review all the pertinent material in the M.C.Z. What began as an innocent offer of help has ended as an appropriation of their research project. I publish my findings in their present incomplete form because some corrections to Barbour's arrangement are clearly necessary, and because it will certainly be some years before I or other interested parties will be able to accomplish all the field work which is still required, and in order to point out the interest of the situation to other students.

The taxonomic history of these anoles is of some interest. There appear to be 36 names of which 20 at present appear to be valid. Much of the older authors' material is without data or, worse, with erroneous data. It is therefore evidence of Cope's perspicacity that he correctly identified more of the earlier described species than any subsequent worker, and that his four new names still stand. Garman and Barbour worked with material of known provenance; however, they misidentified a number of the older species. Consequently some of their names are synonyms of older names. From the *observation* that *many* of the islands have endemic forms they seem to have proceeded in the direction of the *assumption* that *all* the islands have endemic forms; some of their new species are in my opinion not significantly different from already named forms — a conclusion at which I may say that Williams and Shreve had already arrived. Of Garman's twelve new names, at least seven appear to be good. Barbour proposed five new names, four of which appear to be synonyms; he misidentified four forms, and overlooked one unnamed distinct form in the Museum of Comparative Zoology.

These lizards present the familiar nomenclatorial problem of island populations. Given a full knowledge of the relevant facts, which we certainly do not have, there remains a considerable element of personal taste in deciding how to represent them nomenclatorially. I therefore state my personal taste. If two separate island populations appear to have a common immediate origin and have closely similar habits then, although on details of coloration or squamation they may be 100 per cent distinct, I would regard them as subspecies. As I do not have the relevant information on the habits of many forms, the taxonomic rank accorded to them is to be regarded as provisional. In particular in Guadeloupe and its immediate neighbors there are a number of derivatives of the *bimaculatus* group. We do not know enough about their ranges and reproductive isolation to attempt a natural arrangement. I regard colors in life as of primary importance in the discrimination of *Anolis* species. Squamation differences I regard as only indirectly significant by-products of species differentiation, virtually impossible to assess without information about the live animals, and in anoles often difficult to characterize in words. My account is largely confined to adult males since they are the most clearly differentiated.

There appear to be two major groups of anoles in the eastern Caribbean: (1) the *bimaculatus* group, of Greater Antillean affinities, extends through the Leeward group into Dominica, and (2) the *roquet* group, of South American affinities, extends from the mainland through Trinidad, Tobago, Barbados and the Windward islands as far as Martinique. A third group is represented by *A. wattsi* in the northern Leeward Islands and St. Lucia. Happily even juvenile females are distinguishable on squamation characters.

In both major groups the canthal ridge passes into a long supraciliary scale; in the *bimaculatus* group it is followed by a series of differentiated small supraciliaries; in the *roquet* group there is no differentiated series of small supraciliaries.

The caudal scales are arranged in whorls corresponding to the autotomy septa; in the *bimaculatus* group there are three or four dorsal crest scales in each tail whorl; in the *roquet* group there are usually five dorsal scales in each whorl; if there are less it is only as an individual variation and not as a population character.

The supraorbital scale-row continues forward of the orbits and meets the canthal ridge scale-row; in the *bimaculatus* group the forward continuation of the supraorbital row is well defined onto the antorbital area; in the *roquet* group it is ill-defined. There is a pronounced ridge on the supraorbital scale-row. In the *bimaculatus* group it continues onto the antorbital area at least halfway to the level of the nostrils, while in the *roquet* group it scarcely extends beyond the anterior edges of the orbits. Wedged between the canthal ridge and the supraocular scale-row are some scales decidedly larger than the granular supraoculars. In the *bimaculatus* group they are few in number and large; in the *roquet* group they are usually more numerous and smaller (see Fig. 1A and B). This difference is not always very sharp.

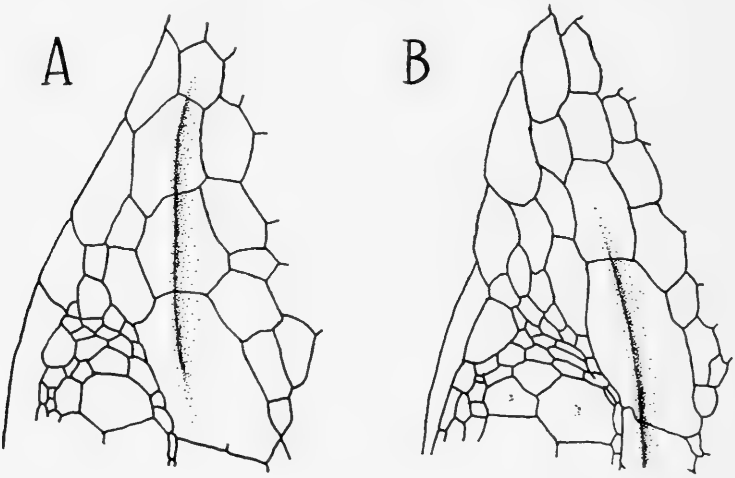


Fig. 1. Scalation of the antorbital region. A, in the *bimaculatus* group, B, in the *roquet* group.

The scales on the throat fan of the males are in well-defined rows; in the *bimaculatus* group the scales are somewhat rounded in outline and flat; in the *roquet* group they are in very well-defined rows of an elongated oval shape and swollen.

In the males of the *bimaculatus* group there is a well-defined pair of enlarged post-anal scales; in the males of the *roquet* group there is a pair of depressions in this position in which the scales may be somewhat differentiated but not enlarged (save in one specimen from Petit Martinique).

Anolis wattsi is distinguishable from the *bimaculatus* group by its small size, narrower digital dilations, strongly keeled belly scales and by a double row of much enlarged vertebral scales which runs from the occiput to the mid-dorsal row of tail scales. The characters by which *bimaculatus* differs from *roquet* distinguish this form as well from the *roquet* complex.

Under each form I cite the name used by Barbour (1930a), who is the most recent previous reviser of these forms. Barbour's later checklists alter the grouping of species and subspecies but not the allocation of names. I give for each form the snout-vent length of a large adult male. I add the range of the form and a list of MCZ specimens studied. For notes on the colors of the animals in life I have drawn upon the observations of Garman (1887) and Barbour (1930a), as well as on my own observations.

I should add an apology to my colleagues for the incompleteness of my personal records for I did not regard myself as being involved in this study as a reviser until after returning from my travels.

ANOLIS BIMACULATUS group

Apart from the squamation characters which distinguish the *bimaculatus* group, a number of features of color pattern run through the group. The primary color appears to be a green which can turn to brown. Some stocks appear to be "fixed" in the brown condition (Saba, Anguilla bank group, Désirade). Conversely some forms are a somber green without a brown phase (Guadeloupe — *alliaceus*). There is a light flank stripe which ranges from conspicuous, as in the Antiguan form, to obsolete as in *alliaceus* from Guadeloupe. There are brown speckles which are generally small as in Antiguan animals but may be very large and dark as in those from Saba or altogether wanting as in Marie Galante specimens. On the ground color there may be light speckles, absent in the forms of northern Leeward Islands, just visible in Montserrat specimens, and forming a very conspicuous pattern as in *marmoratus* from Guadeloupe. It is probable that there are sympatric species and distinct subgroups within the group; study of such questions requires field work.

ANOLIS BIMACULATUS GINGIVINUS Cope

Anolis gingivinus Cope, 1864, Proc. Acad. Nat. Sci. Philadelphia, 1864: 170. Type: B. M. N. H. 1946. 8. 29. 18-20. "Anguilla rock, nr. Trinidad," coll. W. J. Cooper.

Anolis virgatus Garman, 1887, Bull. Essex Inst., 19:41. Type: M.C.Z. 6165, St. Barthélemy, coll. Lagois.

Anolis gingivinus, Barbour.

Not seen alive.

From Garman's description and the appearance of preserved specimens this is a grey lizard which does not have a green color phase; the markings are dark brown. A series from Anguilla has fine dark speckling which may extend from the back of the neck, down the trunk and onto the dorsal surface of the hind limbs or may be so reduced as to be almost lacking. There is subdued grey vermiculation on the anterior trunk. A light flank stripe starts over the shoulder and may extend past the elbow to reach knee level.

A single specimen from St. Martin has transverse bands on the anterior trunk and tail and a dark stripe above the light flank stripe. A series from St. Barthélemy (10) shows better defined grey vermiculation, the flank stripe extending to the groin and, in two specimens, indications of transverse bands. These look like minor local population differences.

Snout-vent. 57 mm.

Range. Anguilla, St. Martin, St. Barthélemy.

MCZ specimens examined. 6157 (Anguilla); 6165 (10) (St. Barthélemy); 16546-595 (Anguilla); 20985 (St. Martin); 33372 (Anguilla).

ANOLIS BIMACULATUS SABANUS Garman

Anolis sabanus Garman, 1887, Bull. Essex Inst., 19:39. Type: M.C.Z. 6161, Saba, coll. Lagois.

Anolis sabanus, Barbour.

Not seen alive.

This very distinct form resembles *gingivinus* in general color; it has distinctive, large, very dark brown blotches; they show some tendency to arrangement in transverse bands. There is a vertebral stripe clear of markings. There is no flank stripe. The throat fan is "lemon yellow" (Barbour).

Snout-vent. 65 mm.

Range. Saba.

MCZ specimens examined. 6161 (5); 28501-26 + dupl.; 33376.

ANOLIS BIMACULATUS BIMACULATUS (Sparrmann)

Lacerta bimaculata Sparrmann, 1784, Nya Handl. Sven. Vet. Akad. Stockholm, 5:169. Type: Mus. de Geer Roy. Stockholm, St. Eustatius, coll. Acrelius.

Anolis edwardsi Merrem, 1820, Syst. Amph.: 45. No type, Nevis.

Anolis reticulatus Gray, 1840, Ann. Mag. Nat. Hist., 5:114. Type: B.M.N.H. 1946.8.29.10, no locality, no collector.

Anolis mayeri Fowler, 1918, Publ. Carnegie Inst. Washington, 252:8. Type: No. 3151 Princeton University. ''Virgin Islands,'' coll. A. D. Brown. (Synonymy *fide* Williams and Shreve.)

Anolis bimaculatus, Barbour.

Seen alive.

A series of six topotypes show a strong blue-green ground color. Creamy markings extend from the upper lip to the neighborhood of the earhole. The flank stripe, prominent on the anterior shoulder, may reach halfway to the groin. There may be some dark spots on the lips, sides of the head, flanks and the base of the tail but their density, form and distribution are very variable. There are vague indications of transverse mottling.

A series from St. Kitts (9 males) is less blue-green and more chalky-green. This appearance is true of the living animals also. The creamy markings are more extensive on the head. The equally well marked flank stripe fades at elbow level. The dark spots may cover trunk, hind limbs and tail or may be absent. These lizards can turn brown. ''Throat, dewlap and venter lemon yellow'' (Barbour). Nevis specimens are very similar and I agree that *Anolis edwardsi* should be regarded as a synonym.

The type of *Anolis reticulatus* is a female without data. The specimen is very dark without any color pattern. In squamation it shows good agreement with Antiguan specimens but somewhat better agreement with St. Kitts specimens. I propose therefore to place *reticulatus* as a synonym of *bimaculatus.*

Snout-vent. 99 mm.

Range. St. Eustatius, St. Kitts, and Nevis.

MCZ specimens examined. 6156 (23), St. Kitts; 6184 (2), Nevis; 10379-402, St. Kitts; 16166, St. Kitts; 16169, Nevis;

16208, Nevis; 16278-95, St. Kitts; 16529-31, 16533-5, 16537, 16539, St. Eustatius; 28714-21, Nevis; 28722-4, Basseterre, St. Kitts; 38277-8, 6 mi. E. of Charleston, Nevis; 54718-19, St. Eustatius.

ANOLIS BIMACULATUS LEACHII Duméril and Bibron

Anolis leachii Duméril and Bibron, 1837, Erp. Gen., 4:153. Type: M.H.N.P. Ig 34/1; "Antilles"; pres. T. Bell.

Anolis antiquae Barbour, 1915, Proc. Biol. Soc. Washington, 28:74. Type: M.C.Z. 10624; Antigua; coll. Wulsin and Noble.

Anolis barbudensis Barbour, 1923, Occ. Pap. Mus. Zool. Univ. Mich., 132:4. Type: M.C.Z. 16167; Barbuda; coll. Forrest.

Seen alive.

The type specimen in Paris is an adult male with a well preserved color pattern. It bears a detailed resemblance to Antiguan specimens. There is speckling from the occiput to the loins, a flank stripe as far as the elbow and dark longitudinal speckling beneath the head. The specimen bears an old label *Anolis bimaculatus.* I suppose that it was initially identified as this species.

This lizard is yellow-green in life with partly confluent brown speckles. There is more confluence of speckles on the anterior trunk, producing a coarsely vermiculate pattern, than on the posterior trunk which has independent speckles. The speckling may fade at the loins or may reach the tail. The flank stripe fades by elbow level. The lizard can turn brown. The throat fan is yellow.

The types of *Anolis barbudensis* are two males. The larger has greatly reduced speckling. The smaller is typically Antiguan in pattern. I regard *barbudensis* as a synonym of *leachii.*

In the London Zoo Mr. R. Lanworn kindly showed me a collection of anoles from Bermuda. Some were the Jamaican species *Anolis g. grahami* which I have myself encountered in Bermuda. The others were quite clearly the Antiguan species. They were correctly identified under the name *Anolis leachii.*

Snout-vent. 89 mm.

Range. Antigua, Barbuda.

MCZ specimens examined. 10624-5, St. Johns, Antigua; 11981-4, Antigua; 16167-8, Barbuda; 55455, Boggy Peak, Antigua; 55456-7, Kensington House, St. John's, Antigua; 55458-9, nr. Crab Hill Village, Antigua; 55677-81, 55773, St. John's Antigua.

ANOLIS BIMACULATUS LIVIDUS Garman

Anolis lividus Garman, 1887, Bull. Essex Inst., 19:43. Type: M.C.Z. 6176; Montserrat; coll. Garman.

Anolis lividus, Barbour.

Seen alive.

The predominant color is bright yellow-green grading to blue on the tail. There is russet around the eye and a variable extension of russet onto the head and forequarters. Oblique rows of pale spots were sometimes present on the sides. The belly is yellow. The flank stripe is never strongly defined and is very variable in its extent. These lizards can turn a warm dark brown. The throat fan is light ochre.

Snout-vent. 70 mm.

Range. Montserrat.

MCZ specimens examined. 6176 (35), 38379 (9), 55686-705, 55837, all from Plymouth, Montserrat.

ANOLIS BIMACULATUS ?LIVIDUS Garman

Anolis nubilus Garman, 1887, Bull. Essex Inst., 19:32. Type: M.C.Z. 6181; Redonda; coll. Richardson.

Anolis nubilus, Barbour.

Not seen alive.

The larger male type of *nubilus* is larger than *lividus*. There is not the same clear indication of a green color phase. The light speckling is pronounced on the hindlimbs where the speckles are fairly large. There is almost no trace of the flank stripe. The distinctness of this population cannot be judged from three preserved specimens. I propose that it be placed under *lividus* until a larger series can be compared directly with living material.

Snout-vent. 80 mm.

Range. Redonda.

MCZ specimens examined. 6181 (3), Redonda.

ANOLIS BIMACULATUS ALLIACEUS Cope

Anolis alliaceus Cope, 1864, Proc. Acad. Nat. Sci. Philadelphia, 175. Type: B.M.N.H. 1946.8.28.96; no locality; purchased of M. Parduzaki.

Anolis leachii, Barbour.

Not seen alive.

The type is a fairly well preserved adult male which shows some pattern. It is quite clearly an example of the species common in Guadeloupe. Above each shoulder is a light-edged horizontal black patch (divided on the left). Further forwards on the side of the neck are smaller similar marks; on the posterior head and anterior trunk are dark vermiculations.

Most of the preserved specimens are very dark but it appears that they have a green color phase. Most have black light-edged blotches on the anterior trunk. In some specimens they may be partly joined to form transverse markings. There is commonly a well-defined horizontal black patch over the shoulder. There is no flank stripe. There may be indications of vermiculations as well as black markings on the anterior trunk.

At the time of going to press I learned from Dr. Williams that he is satisfied that the series of specimens from St. Rose, Guadeloupe, which I have regarded as *alliaceus*, represent an undescribed species. One of the characters is uniform dark coloration without any black markings. Fortunately this character raises no question about the identity of *alliaceus*, under which name the St. Claude series will remain. It does, however, raise a question about the type of *reticulatus*.

Snout-vent. 71 mm.

Range. Guadeloupe, Basse-Terre only?

MCZ specimens examined. 10314-363, St. Claude, Guadeloupe; 10403-425, St. Rose, Guadeloupe.

ANOLIS MARMORATUS Duméril and Bibron

Anolis marmoratus Duméril and Bibron, 1837, Erp. Gen., 4:139. Type: M.H.N.P. Ig. 43, paratype Ig 43/1; ''Martinique''; coll. Plée.

Not seen alive.

The two original specimens are adult males; the bellies are rather soft but the pattern is well preserved. As soon as I saw these specimens I was sure that I had not seen the species before and equally sure that I would recognize it when next I saw it. In particular, the color pattern does not resemble that of any of the specimens from Désirade in the M.C.Z. The species belongs to the *bimaculatus* group and shows some resemblance in color pattern to the form in Dominica.

I was initially inclined to accept the Martinique locality as correct. As matters stand, only one representative of the *roquet* group is known from Martinique; the occurrence there of a representative of the *bimaculatus* group, bearing some resemblance to the Dominican form, seemed entirely plausible. I regarded Martinique as the meeting ground between Antillean and South American stocks. However, in the U.S.N.M., I found five specimens of *marmoratus,* all collected by L. Guesde, as follows: 11174, ♂; 11180, ♂ — Guadeloupe; 11183, 2♂; 11184, ♀ — Capesterre, Guadeloupe. A number of Plée localities are known to be erroneous. Is this Guesde locality more reliable? The addition af an exact locality (Capesterre is in S.E. Basse-Terre) to one of the collections lends authenticity. That Guesde collected in Guadeloupe and dependencies is clear from other material in the museum: There are specimens of *ferreus* from Marie Galante. Two males, USNM 11181, from "St. Barthélemy and St. Martin" are certainly not *gingivinus* and closely resemble the Désirade form. This however still does not take us outside the political limits of Guadeloupe. (It is relevant that Louis Guesde was a resident of Guadeloupe well known locally for his interest in Amerindian remains.) Further the U.S.N.M. does not have anoles from Martinique collected by Guesde. I therefore assume that *marmoratus* represents a second Guadeloupe species.

The forelimbs, hindlimbs and posterior trunk are uniform and, as preserved, dark chocolate brown. On this dark ground color the head and dorsal neck have a very striking pattern of light speckles, partly confluent and more or less organized into stripes with irregular borders. A light stripe runs from the posterior part of the canthal ridge over the supraciliary scales, expands on the supraocular region to isolate two dark spots on the supraocular disc, passes across the temple and curves in towards the midline (save in 11174) behind the parietal region. Another light stripe follows each supraorbital scale row. There is a group of light speckles on the antorbital depression and a group of partially confluent speckles on each parietal area. A median light stripe runs along the nuchal crest (interrupted in smaller 11183). A light stripe along the upper lip, interrupted by dark speckles, passes into a row of light speckles running from the corner of the mouth across the earhole and onto the side of the neck where it becomes the middle member of three roughly organised rows of light speckles.

The light speckles on the neck extend down the sides to about the shoulder level; they do not extend backwards as far as the shoulders. A light flank stripe extends back from over the shoulder and fades out before reaching elbow level (absent in 11174). There may be a few dark speckles on the lower lip and on the underside of the head. The single female is without evident markings.

In the U.S.N.M. register the Capesterre Guesde collection bears in the remarks column the note "Anolis tête-rouge." Guesde was presumably either reporting a local name or giving an indication of the appearance of this form.

Snout-vent. 67 mm.

Range. Guadeloupe, Basse-Terre only?

No MCZ specimens examined.

ANOLIS new species

Anolis marmoratus, Barbour.

A series of 35 specimens collected on Désirade by Richardson clearly represents an undescribed form. It appears to be brown with a greenish tinge. There are pale vermiculations on the trunk reminiscent of *leachii*. Brown speckles may be present on the trunk; when well defined they also extend onto the head. Solely on the basis of preserved material, without knowledge of the living animals, I do not feel that I can properly describe and name it.

Snout-vent. 68 mm.

Range. Désirade.

MCZ specimens examined. 6166 (35), Désirade.

ANOLIS FERREUS (Cope)

Xiphosurus ferreus Cope, 1864, Proc. Acad. Nat. Sci. Philadelphia, 168. Type: B.M.N.H. 1946.8.5.59; "Guadeloupe"; no collector.

Anolis asper Garman, 1887, Proc. Essex Inst., 19:31. Type: M.C.Z. 6162; Marie Galante; coll. Richardson.

Anolis asper, Barbour.

Not seen alive.

The type specimen, a large male, is quite unmistakably the larger Marie Galante species with crested tail. In the general color, as preserved, and in lack of pattern it further agrees with this Marie Galante form. As Marie Galante lies in the administration of Guadeloupe the erroneous locality ascription could easily occur. All the specimens which I have seen are uniformly light and patternless. According to Barbour the males are bright green or brown with a throat fan of grey with a wide lemon yellow margin. The proximal half of the tail of the male bears a very high crest supported by the neural spines.

Largest male, snout-vent: 98 mm.; tail crest; 14½ mm. high.

Specimen with largest crest, snout-vent: 91 mm.; tail crest: 17 mm. high.

Range. Marie Galante.

MCZ specimens examined. 6162 (18), 28526-41 + dupl., Marie Galante.

ANOLIS SPECIOSUS SPECIOSUS Garman

Anolis speciosus Garman, 1887, Bull. Essex Inst., 19:42. Cotypes: M.C.Z. 6172; Marie Galante; coll. Richardson.

Anolis speciosus, Barbour.

Not seen alive.

On the evidence of the five male cotypes, this form is distinct from *alliaceus*. In life they are evidently green lizards. The anterior head is a little darker than the rest of the body; they are otherwise quite uniform; there are no indications of spots, vermiculations or flank stripe.

Snout-vent. 62 mm.

Range. Marie Galante.

MCZ specimens examined. 6172 (5), Marie Galante.

ANOLIS SPECIOSUS TERRAEALTAE, Barbour

Anolis terraealtae Barbour, 1915, Proc. Biol. Soc. Washington, 28:76. Cotypes: M.C.Z. 10627; Terre d'en Haut, Iles des Saintes; coll. Noble.

Not seen alive.

On the basis of the type series *terraealtae* is obviously different from *alliaceus;* its distinction from *speciosus* is less striking however. The greenness is less marked, the anterior head is distinctly brown. U.S.N.M. 79002 (♂) and 79003 (♀) from St. George (= Cabritt) appear to belong to this form and are plain brown. The four types (3♂, 1♀) bear curious irregular brown patches of various sizes on trunk, limbs and tail. They look like artifacts but I am unable to visualize a preservation procedure which could produce such markings; perhaps the effect could be produced by splashing with formalin (which causes expansion of the melanophores). On this evidence they may be capable of a green and a brown color phase. The allocation is provisional; both forms may well join the *bimaculatus* series.

Snout-vent. 68 mm.

Range. Iles des Saintes.

MCZ specimens examined. 10627-30, Terre d'en Haut, Iles des Saintes.

ANOLIS OCULATUS (Cope)

Xiphosurus oculatus Cope, 1879, Proc. Amer. Phil. Soc., 18:274. Cotypes: U.S.N.M. 10139-48, -50, -51, -53 and 7426; Dominica; coll. Ober.

Anolis alliaceus, Barbour.

Seen alive.

After two visits to the island and examination of more than sixty preserved specimens I remain uncertain about the situation in Dominica. The best way to explain my difficulties is to tell the story.

On my first visit I collected a number of anoles in Roseau. I sent some alive to the M.C.Z. Williams reported that after making generous allowance for the effects of preservation he could not reconcile them with specimens taken by Barbour in the Botanical Gardens in 1928. I took brown lizards capable of only slight color change and quite incapable of a green phase. Barbour's specimens were somber green lizards with black-edged white ocelli in oblique rows on the sides. I had apparently taken a new species in one hour ashore without moving outside the capital!

On my return visit to Dominica I had therefore simply to make my way to the Botanical Gardens to collect a series of Barbour's species and thus confirm this interpretation. After two hours of the most careful searching both in the Botanical Gardens and in the surrounding bush I took only two females of the species which I had already met. On my return to the ship a fellow passenger, Dr. W. G. Downs, Director of the Trinidad Regional Virus Laboratory, described to me a "beautiful *Anolis*" which he had seen by the waterfall. His description closely matched Williams' account of Barbour's material in the M.C.Z. There had evidently been some shift of population during the last 28 years, but Dr. Downs' testimony settled the existence of two species.

When I examined the large number of specimens in the M.C.Z. I confidently expected to be able to sort them into two species. I was therefore disconcerted to find every kind of annectant variant between specimens with black-edged white ocelli and plain brown specimens. The type series is, happily, rather uniform as compared with other series. Males 10139, -40, -42 to -45 bear black-edged white ocelli; only male 10147 is without black markings; the remainder are grown females, save a small juvenile no. 7426.

A common pattern variant may be described as follows. The head is a plain brown, about four oblique rows of four white spots on each flank, the upper anterior spots edged with black, a few more white spots on the neck. Light speckles (rather than white) on the back of the neck and down the trunk (between the ocelli) onto the base of the tail. Vague light mottling on the limbs. The amount of black around the white spots may be reduced to the point of absence. The number of white spots may be reduced. The light speckling may extend all over the head or conversely may be inconspicuous, although still present. One specimen had small white spots (without black edges) all over the body including the head, limbs and tail. Some specimens showed light speckling on the neck resembling that of *marmoratus; oculatus* may perhaps be placed as a subspecies of *marmoratus*.

Apart from the difference between my collection and Barbour's collection, I found other reason to suspect local population variation. A series in the U.S.N.M. from near Portsmouth (N. Dominica) had very conspicuous white spots extending onto the head, even onto the snout, showing a tendency to form oblique rows on the flanks with very little if any black edging. Clearly, Dominica will require further careful examination.

Snout-vent. 73 mm.

Range. Dominica.

MCZ specimens examined. 6160 (45) Roseau, Dominica; 6159 (19) Portsmouth, Dominica; 28593, 55706-8, Roseau, Dominica.

Anolis roquet group

Whether the name *roquet* should be applied to this group is not completely certain; this is discussed under the species *roquet*.

The group falls into three series of forms each distinguished by color characters. The *roquet* series consists of spotted lizards. The spots are much darker than the ground color, more or less black, varying in size from no more than one scale to mottles as large as the eye. The ground color is green which can turn dark brown or (in Trinidad) grey. There may be more or less well defined darker transverse bands on the ground color. The pineal window is surrounded by black pigment. This series is represented on the mainland and in Trinidad, Grenada, Grenadines, St. Lucia, Martinique and Barbados.

The *trinitatis* series consists of plain green lizards which can turn brown. The head is darker than the trunk; the pineal window is surrounded by white pigment. This series is represented in Trinidad, St. Vincent, St. Lucia and perhaps in Martinique.

The *richardii* series is comprised of large lizards, which as adult males show prominent bony ridges on the skull. The colors are rather dull, grey and olive, and there is not much power of color change. This series is represented in Tobago, Grenada and the Grenadines and St. Vincent.

Only one form has hitherto been reported from St. Lucia, a member of the *trinitatis* series. In a few hours collecting in the botanical gardens in Castries I gathered sufficient material to be certain that there is a second species, a member of the *roquet* series. Last year Mr. G. R. Proctor making a visit of a few hours to St. Lucia went up into the rain forest. He brought back a single small *Anolis* which had blue eyes. I identified the specimen as *luciae* and regarded the blue eyes as an aberration. On a second, extended visit Proctor reported the blue-eyed specimens from several localities and established what I believe to be the first reported case for the Lesser Antilles of two closely related forms with an allopatric distribution, this within an island which would go four times into the area of Rhode Island. I describe and name this form below.

Anolis roquet roquet (Lacépède)

Lacerta roquet Lacépède, 1788, Hist. Nat. Quad. Ovip. Serp., 1. No type; Martinique; no collector.

Anolis alligator Duméril and Bibron, 1837, Erp. Gen., 4:134. 3 cotypes: M.H.N.P. Ig55/1; 1 cotype Ig55/2; Martinique; coll. Droz and Plée.
Anolis goudotii Duméril and Bibron, 1837, Erp. Gen., 4:108. Type: M.H.N.P. Ig 55; Martinique; coll. Goudot.
Anolis roquet, Barbour.

Not seen alive.

By itself, Lacépède's description is not sufficient to make the species identifiable. On the testimony of Doflein (1908, p. 245), there are three species of *Anolis* in Martinique, a green, a brown, and a grey with spots. The museum material which I have examined does not appear to be referable to more than one species. In the light of field experience I would suggest that Doflein's evidence argues for the existence of at least two species. The green and the brown may well be color phases of the same species; I have met people in Jamaica who have thought the green and black phases of *Anolis grahami* to be different species. Williams suggests that this may be an undiscovered Martinican representative of the *trinitatis* series. The other form is described by Doflein as "hellgrau mit dunkleren Flecken marmoriert." This agrees with the form in museum collections, and Lacépède's remark "couleur de feuille morte, tachetee de jaune et de noiratre" certainly agrees better with the form in collections than with a plain green or plain brown lizard. It therefore seems reasonably sure that the name "*roquet*" is properly applied.

If we allow *roquet* as the correct name, then *alligator* is certainly a synonym. The Droz cotypes are soft and faded but the color indicates clearly that they agree with Martinique specimens. The Plée cotype is shrivelled but the pattern shows clearly and unmistakably and there is no doubt that it is also the Martinique form.

The type of *goudotii* is a small, probably female juvenile which is virtually unidentifiable. A broad light stripe with dark edges, interrupted on the base of the tail, runs down the back. This pattern agrees quite well with some juvenile *roquet*. At present I see no reason to question the allocation of *goudotii* as a synonym of *roquet*. If, however, material of two or more species is collected on Martinique the type of *goudotii* will have to be re-examined.

It is evident from preserved material that *roquet* is a variable form. There appear to be three main elements in the various color patterns: white spots on the flanks which tend to be arranged in oblique transverse rows; transverse bands, dark on a lighter ground, which include the rows of white spots when they are present; mottling of the ground color which may range from fine vermiculation to conspicuous marbling. The head is usually uniform and darker than the body but the mottling may extend onto the head. Conspicuous mottling, transverse banding and conspicuous white spots may be present simultaneously. Commonly, the mottling is inconspicuous and the bands also inconspicuous. Less commonly the white spots are reduced; in a few specimens they were absent. The general color of the lizard is evidently green in life. Barbour reports that the throat fan is a "rich orange yellow."

Snout-vent. 75 mm.

Range. Martinique.

MCZ specimens examined. 5757, 6008 (30), 6188 (24), 6189 (3), 20526.

The other members of the *roquet* group are perhaps best unravelled by starting with a discussion of the forms on Trinidad. When I saw living examples for myself I was immediately convinced of the claim of Messrs. Quesnel and Kenny that "*Anolis aeneus*" consists of two species. For the purposes of the following discussion I will refer to these two species as the "spotted" form and the "green" form. Two names are available: *Anolis aeneus* Gray 1840 and *Anolis trinitatis* Reinhardt and Lütken 1862.

ANOLIS ROQUET AENEUS Gray

Anolis aeneus Gray, 1840, Ann. Mag. Nat. Hist., 5:114.
Type: B.M.N.H. 1946.8.28.7; no locality; pres. T. Bell.
Anolis gentilis Garman, 1887, Bull. Essex Inst., 19:34.
Type: M.C.Z. 6163, Petit Martinique; coll. Garman.
Anolis aeneus (partim) Barbour.

Trinidad specimens, but not those from the Grenadines, seen alive.

The type is a half-grown male without locality. "Tropical America" given by Barbour is evidently a later addition; in any case Barbour does not give the original literature citation.

There is no evidence of locality at all. Gray gave an account of material collected by McLeay in Cuba. At the end, he described a few more odd specimens in the museum; the only information about this one is that it was presented by Thomas Bell.

This proved to be the most difficult type specimen to allocate. It is quite well preserved but somewhat faded; as a half-grown male it would not show a distinctive color pattern in any case. I am quite satisfied that it is not the green form; the pattern, as much as is visible, does not agree and, for what it is worth, the squamation also does not agree. It shows definite resemblances to small specimens of the spotted Trinidadian form. I find it difficult to make a plausible allocation to territory. Relevant to this question is material from the Grenadines, Grenada, Barbados, Trinidad and British Guiana. I have seen only preserved material from British Guiana and the Grenadines; of these latter I have seen series from Becquia (B.M.N.H.) in the northern part of the group, Cannouan (B.M.N.H. and M.C.Z.), near the center, and Carriacou (B.M.N.H. and M.C.Z.) and Petit Martinique (M.C.Z.) in the south. The Grenadian and Barbadian lizards are in life spotted on a green ground color. The Trinidadian lizards are different in that they are spotted on a grey ground color; they are incapable of a green phase. The preserved material from British Guiana agrees well with the Trinidadian and gives no hint of greenness. The preserved specimens from the several Grenadines agree well with one another and, surprisingly, agree much better with Trinidadian specimens than they do with Grenadian or Barbadian material. A few of the Grenadine specimens show a green tinge; none shows the clear indications of greenness shown by preserved Grenadian specimens. The metallic tinge of the *aeneus* type can be better matched by small Trinidad and Grenadine specimens.

In respect of color pattern and squamation it showed the best combined agreement with a specimen of similar size from Becquia; it agreed in respect of the transverse marks behind the chin and the longitudinal marks on the throat and in the faint indication of pattern beside the neck and over the shoulder. I therefore consider *aeneus* to be the correct name for the grey Trinidadian species and *gentilis* provisionally to be a synonym of *aeneus*. Mr. Shreve had come to the same rather surprising conclusion that the Grenadine specimens resemble the Trinidadian, and the Grenadian resemble the Barbadian. The placing of *gentilis* as a synonym of *aeneus* is provisional pending a direct comparison of living Grenadine and Trinidadian material. If it transpires, as well it may, that there is a distinction between Grenadine and Trinidadian specimens, then the question of the provenance of *aeneus* will become acute and the type will have to be compared anew. Even then it may well be necessary to claim reviser's privilege to assign a type locality to *aeneus*. I hope that Trinidad will be so designated, thus making the name *gentilis* available for the Grenadine form; this latter name is founded on a series of specimens of exact provenance and including adult males.

Trinidadian *aeneus* is essentially a grey lizard; there may be a trace of copper green. There are fuzzy warm brown transverse bands, five on the trunk, extending onto the tail. The whole is liberally sprinkled with dark spots. The lizard is capable of little color change. The fan is a dirty grey with sometimes a faint wash of verdigris. The Grenadine specimens look as though they are sometimes a little greener; the majority resemble the Trinidad specimens closely. There were no obvious indications of differentiation within the Grenadine islands.

Snout-vent. 75 mm.

Range. Trinidad, the Grenadines and British Guiana.

MCZ specimens examined. 6163, Petit Martinique, Grenadines; 6187 (13), 6192 (8), Port of Spain, Trinidad; 20531-5, Carriacou, Grenadines; 33387-92, Canouan Id., Grenadines; 55534, 55537, Trinidad: 55675, 55787-800, Port-of-Spain, Trinidad.

ANOLIS ROQUET CINEREUS Garman

Anolis roquet var. *cinereus* Garman, 1887, Bull. Essex Inst., 19:35. Type: MCZ 6182; St. George, Grenada; coll. Garman.

Anolis roquet var. *extremus* Garman, 1887, Bull. Essex Inst., 19:35. Type: MCZ 6183 Bridgetown, Barbados; coll. Garman.

Anolis roquet gentilis partim Barbour.

Anolis aeneus partim Barbour.

Seen alive.

On the basis of preserved material both the Grenadian and Barbadian populations are very variable and overlap so broadly that I cannot at present see any ground for making a nomenclatural distinction between them.

They both have a green ground color which can change to a warm dark brown. Some of the living specimens seen in St. George's were rather yellowish-green, some in Bridgetown rather bluish-green. The skin around the eyes is dark; the rest of the body is sprinkled with dark spots. Indications of transverse bands which descend the flanks obliquely were very variable. In some specimens there is no indication of banding, while in others the ground color is a little darker in the form of bands; in still others there are pronounced dark bands. In these latter cases the bands may be associated with oblique rows of white spots. Throat fan medium yellow ochre.

Snout-vent. 74 mm.

Range. Grenada, Barbados.

MCZ specimens examined. 2743 (11), Barbados; 6182 (19), St. George, Grenada; 6183 (17), Bridgetown, Barbados; 8132-56, Sauteurs, Grenada; 55401-6, Jamestown, Barbados; 55536, Grenada; 55764, St. George, Grenada.

ANOLIS ROQUET ?CINEREUS Garman

I provisionally refer to *cinereus* the *roquet* representative from St. Lucia, here reported for the first time. The possibility that it is an introduction should be considered. Museum material of Grenadian and Barbadian *cinereus* shows considerable variation which may well be sufficient to include the St. Lucian *cinereus*. The St. Lucia specimens are known only from Castries. Furthermore, from personal recollection of the living animals and the appearance of the preserved specimens there is a special resemblance between Castries *cinereus* and Bridgetown *cinereus*.

The description below of the colors in life is based on personal observations, Proctor's field notes and three specimens received alive through the kindness of Mr. Gregory Williams. Ground color: head and back lavender grey, grades into yellow-green on the flanks, forelimbs, hindlimbs and tail; belly warm chrome-yellow; underside of head grey-blue. Throat fan bright orange-yellow. Body sprinkled with ragged black mottling of variable extent, heaviest on top of the head and dorsal neck, more sparse on back, extends only slightly if at all onto limbs and tail; inconspicuous but distinct lavender grey flank stripe from shoulder to groin.

Snout-vent. 68 mm.

Range. St. Lucia, Castries only?

MCZ specimens examined. 56385-93, Castries, St. Lucia.

ANOLIS TRINITATIS TRINITATIS Reinhardt and Lütken

Anolis trinitatis Reinhardt and Lütken, 1863, Vid. Meddel. Kjøbenk., 1862:269. Type: Universitetets Museum, Copenhagen; Trinidad; coll. Riise.

Anolis aeneus (partim) Barbour.

Seen alive.

This is one of the species of which I have not seen the type specimen. As this specimen bears a precise locality, the only point at issue was whether it is referable to the spotty or the green species of Trinidad. I accordingly wrote to Dr. F. W. Braestrup and he very kindly checked the specimen and the original description. I am happy to say that his reply leaves no doubt but that Reinhardt and Lütken described and named the green form. I say "happy" because these authors worked at a time when many workers were quite content to found new species on badly preserved immature specimens of unknown origin without a word to suggest that they realized that the animals had ever been alive.

I quote from Dr. Braestrup's letter: "Concerning *Anolis trinitatis* I am sorry to say that the type is very badly faded, but we have the statement by R. and L. towards the close of the Danish description (translated by me): 'The color is bluish green on the body; more bluish violet, bronzy on the limbs. The head is darker and especially it seems to have a black area around the eyes; in some a light stripe along the upper lip under the eye is very distinct.' (There is further a footnote to this stating 'In the living animal these markings are perhaps not found at all.') . . . the specimen designated type is 70 mm. from snout to vent. R. and L. were, I believe, always very careful in their descriptions and I think that we may be sure that there were no transverse bars on the body. . . . The type designation is found in our old catalogues and it was no doubt made by the authors themselves even although they did not in print expressly designate it.'' The type specimen is somewhat larger than the largest Trinidad specimen which I collected.

In life *trinitatis* is a bright grass green, and can turn a dark brown. The skin around the eye is dark and on the head and anterior trunk is a little fine blue mottling.

Snout-vent. 70 mm.
Range. Trinidad.
No MCZ specimens at the time of writing.

Anolis trinitatis vincentii Garman

Anolis vincentii Garman, 1887, Bull. Essex Inst., 19:46. Types: MCZ 6178-9; St. Vincent; coll. Garman.
Anolis vincentii Barbour.

Seen alive.

The St. Vincent anoles resemble *trinitatis* but the series of living specimens seen showed some small but clear differences. The ground color is the same but the light blue mottles on the anterior trunk are more extensive in *vincentii.* The clearest difference is that in *vincentii* the area around the eye is light blue in the living animal. The throat fan is a similar orange-yellow.

Snout-vent. 70 mm.

Range. St. Vincent.

MCZ specimens examined. 6178 (47), 6179 (22), 20542-8, 38185-9, 38382, 55532, 55993, Kingstown, St. Vincent.

Anolis trinitatis luciae Garman

Anolis luciae Garman, 1887, Bull. Essex Inst., 19:44. Type: MCZ 6173; St. Lucia; coll. Garman.
Anolis luciae, Barbour.

Seen alive.

I have placed this form in the *trinitatis* series at the suggestion of Dr. Williams; it is a suggestion with which I fully agree. This form reaches a greater length of body and is more slenderly built than the *roquet* representative in St. Lucia. The general color is brown to olive; the power of color change is quite limited; the belly is white. The head is plain brown; the lips are paler, flecked with darker pigment. The pineal window is larger than in *roquet* and surrounded by white pigment. The iris is black;

the fan has a pale yellow center. There is vermiculate speckling of brown on olive, especially on the anterior trunk; there is a light shoulder stripe which does not pass the elbow.

Snout-vent. 81 mm.

Range. St. Lucia, recorded from Castries (Barbour, Underwood) and Vieux Fort (Proctor).

MCZ specimens examined. 6173 (20), 6175 (1), Castries, St. Lucia; 20549, St. Lucia; 56394-411, Castries, St. Lucia.

ANOLIS TRINITATIS PROCURATORIS subsp. nov.

Type: M.C.Z. 57202, adult male, Savanne Edmund, St. Lucia, 13°47′N, 61°1/2′W, collected by G. R. Proctor, May 1958.

Fig. 2. St. Lucia. Localities for the four anoles known from the island.

Paratype: M.C.Z. 57203, adult female, same data as type.

Color in life reported by G. R. Proctor.

Diagnosis. An *Anolis* of the *trinitatis* series closely related to *luciae*. Differs from all the other members of the series in the blue iris and the greenness of the belly and the underside of the head; differs from *luciae*, additionally, in the power of color change from green to brown.

The general color is blue-green, the animal is capable of marked color change to an olive brown, the belly and the underside of the head are green. The head is brown; the area around the pineal window is a little more conspicuously white than in *luciae.* The iris is cobalt blue, the throat fan has a pale yellow center as in *luciae.* Indications of vermiculation are slight; the shoulder stripe is almost obsolete. No consistent differences of squamation were found.

Apart from the type locality, this form is recorded from Marquis (Proctor, 1 specimen) and Bare de l'isle (Proctor, specimen). I received three specimens from Soufrière collected by Mr. Gregory Williams. He reported that the eyes were blue in life; as preserved, they differ from the type in that they are yellow-green rather than blue-green. He also reports blue-eyed anoles from La Vigie about 1½ miles northwest and La Clery about 1 mile north of Castries. The boundary zone evidently runs close to the capital.

The records for this form suggest that the range of *luciae* may be discontinuous, interrupted by *procuratoris;* they further suggest that *procuratoris* may not be completely confined to forested country. We have a pair of forms, one showing marked color change and found (mostly) in forested country and one showing more limited power of color change and found in more open country. The St. Lucian pair *procuratoris* and *luciae* may thus be compared to the Jamaican pair *Anolis lineatopus neckeri* and *A.l. lineatopus. Neckeri* shows a considerable power of color change and is found in forested country; *lineatopus* shows a limited power of color change and is found in drier more open country.

Caribbean reptiles bear many patronymics, some of which mean rather little. Mr. G. R. Proctor is a field botanist who has shown himself to be a discriminating collector of reptiles, on this and other occasions, and I am happy to make this recognition of his contribution. The name Proctor is a syncopated form of procurator which is a classical Latin term.

Snout-vent. 74 mm.

Range. St. Lucia: Savanne Edmund, Marquis, Soufrière, Barre de l'Isle, La Vigie, La Clery.

ANOLIS RICHARDII RICHARDII Duméril and Bibron

Anolis richardii Duméril and Bibron, 1837, Erp. Gen., 4:141. Type: M.H.N.P. Ig 53; ''Tortola''; coll. Richard.

Anolis occipitalis Gray, 1840, Ann. Nat. Hist., 5:112. Types: B.M.N.H. 1946.8.12.59, 1946.8.29.11 ''West Indies''; coll. T. Bell.

Anolis stenodactylus Gray, 1840, Ann. Nat. Hist., 5:114. Type: B.M.N.H. 1946.6.8.12.54 ''Jamaica''; coll. J. Winterbottom.

Anolis trossulus Garman, 1887, Bull. Essex Inst., 19:38. Type: M.C.Z. 6181; Grenada; coll. Garman.

Anolis richardii, Barbour.

The type specimen is a half-grown male. No color pattern is visible. The specimen bears a detailed resemblance to Grenadian and Tobagonian material. The populations in the two islands so closely resemble one another that I could not guess from which island the specimen had more probably come.

Adults are a dull olive green. There are cream markings on the lips which may extend onto the temporal region. There are variable indications of dark hour-glass markings across the back. The throat fan is a light ochre yellow and very large (but the basihyoid cartilage is not correspondingly long). The lizards can turn a dull dark brown. The smaller individuals are a brighter green with a warm dark brown phase. Some have a light stripe on the shoulder which starts obliquely backwards and upwards to fade on the flank; a second parallel stripe starts below it on the flank and runs backwards and upwards to the groin.

I did not see any juveniles in Grenada but the similarity of the adults is close.

Snout-vent. 125 mm.

Range. Tobago, Grenada (and the Grenadines *fide* Cochran 1934 and 1938).

MCZ specimens examined. 6181 (12), 8108-31, St. George's, Grenada; 10748, Tobago; 12016-26, Milford Bay, S.W. Tobago, 55676, Grenada.

ANOLIS RICHARDII GRISEUS Garman

Anolis griseus Garman, 1887, Bull. Essex Inst., 19:36. Type: M.C.Z. 6164; St. Vincent; coll. Garman.

Anolis griseus, Barbour.

This form was seen only preserved. It appears to be somewhat lighter than *richardii;* the ground color has a greenish tinge. The body generally bears reticulate or vermiculate markings. There is a short light stripe over the shoulder only; a longer stripe starts below the axilla and runs backwards and upwards to the groin. There is no evidence of creamy markings on the lips. There may be dark brown spots on the anterior trunk which tend to form oblique rings. If the specimens examined represent a fair sample of the population, then these lizards do not grow quite as large as *richardii.*

Snout-vent. 117 mm.

Range. St. Vincent.

MCZ specimens examined. 6164 (5), St. Vincent; 38380-1, Fountain Estate, St. Vincent.

ANOLIS WATTSI Boulenger

Anolis wattsi Boulenger, 1894, Ann. Mag. Nat. Hist., (6)14:375. Type: B.M.N.H. 1946.8.29.12-13; Antigua; coll. Watts.

Anolis forresti Barbour, 1923, Occ. Pap. Mus. Zool. Univ. Mich., 132:4. Type: MCZ 16170; Barbuda; coll. Forrest.

Anolis wattsi, Barbour.

Antigua and St. Kitts specimens seen alive.

Antiguan specimens of this small lizard are attractively colored. Overall is medium brown. The head and especially the snout is bright russet. There is a luminous translucence about the colors. The temples are blue-grey. The throat fan is light orange.

Only two specimens were seen in St. Kitts. They had only a little russet on the snout and lacked the blue-grey on the temples. Museum specimens indicate the occurrence of this lizard in Anguilla, St. Martin, St. Eustatius, St. Kitts, Nevis, Barbuda and Antigua; it presumably also occurs in St. Barthélemy. It has not been reported from Montserrat.

In Proctor's St. Lucia material Williams found specimens of *Anolis wattsi* collected in Castries. This startling discovery was confirmed by a collection of anoles from Castries which Mr. Gregory Williams shipped to me. Unfortunately, the three specimens of *wattsi* were dead and I can only report that the colors of the dried animals resemble Antiguan *wattsi.* It may well turn out to be a distinct subspecies.

Snout-vent. 49 mm.

Range. St. Martin, Anguilla, St. Kitts bank, Antigua bank, St. Lucia.

MCZ specimens examined. 10134, St. Johns, Antigua; 12334-6, St. Eustatius; 16170, 16201-5, Barbuda; 16213-15, Nevis; 16538-43, St. Eustatius; 16596-7, Anguilla; 20986, St. Martin; 21676-9, Antigua; 28563-68, St. John, Antigua; 28696-99, St. Kitts; 38375-6, 6 mi. E. of Charleston, Nevis; 54708, St. Eustatius; 55460 nr. Crab Hill Village, Antigua; 55461 nr. All Saints, Antigua; 55462-4 nr. Old Road Town, Antigua; 55465, Boggy Peak, Antigua; 55535, 55682-5, St. John's, Antigua; 57220-1, Castries, St. Lucia.

FIELD OBSERVATIONS

Basseterre, St. Kitts, was the poorest collecting locality of my trip. In the higher class residential section of the town, to the northwest, there were numbers of *bimaculatus.* A search for cool and shady clumps of trees which might be expected to harbor *wattsi* was fruitless. The ''Botanical Station'' proved to be merely a rather bare nursery. Two *wattsi* were eventually found in a churchyard.

In Montserrat, *Anolis lividus* was abundant both in shady places in Plymouth and in open situations in the cemetery. No indications of the occurrence of a second species were seen.

The botanical gardens in St. John's, Antigua, proved to be a good collecting ground. *Leachii* was the more obvious because it occurred in more open situations. In the gardens *wattsi* was common but appeared definitely to prefer shady situations; it is therefore probably more localized in its occurrence.

All the anoles collected in Dominica were in open situations. Some were on walls and trees in Roseau, others were seen on trees outside the town. In woodland around the botanical gardens no anoles were seen.

In St. Lucia there was good collecting in the botanical gardens; with the aid of small boys a good series was collected. My impression is that *luciae* prefers open situations and that the *roquet* form prefers shady places. This difference in habits did not appear to be sharply marked however.

There was no difficulty in obtaining a series in Bridgetown, Barbados, on trees, in open situations, in yards, and by the creek.

I did not have time to get very far in Kingstown, St. Vincent; *vincentii* proved to be quite common on trees and fences in the town along the waterfront. I was told about a larger tree lizard, evidently *griseus*. It is known locally as "coco-bé." Later I was told that a distinction is made between "coco-bé" and "coco-tom," brown and green respectively. I am not clear whether these are color phases of the same species or *griseus* and *vincentii*, respectively.

In Grenada I made my way from St. George's towards the botanical gardens but never arrived, for there was excellent collecting on roadside trees. Both *cinereus* and *richardii* were in evidence, and both appeared to be common. They were seen on the shaded side of trees out in the open. *Richardii* was not found on fence posts where *cinereus* was however seen. On the road up to the fort some *cinereus* were also seen on stone walls.

In Trinidad, very fortunately, as it now turns out, *trinitatis* was quite common in the garden of the guest house in which we stayed near the southwest corner of Queen's Park Savanna. *Aeneus* was not seen in this garden, which in the course of one month was the only locality in which I saw *trinitatis*. In gardens 100 metres away *aeneus* was found to the exclusion of *trinitatis*. Along a line of fence posts enclosing the dock area, in a very open and sunny situation, *aeneus* was fairly common. The one garden in which *trinitatis* was found was, on the other hand, cool and shady. The unrelated Trinidad species *chrysolepis* was not seen. I was informed that it occurs in the forest and is relatively rarely seen.

In Tobago, *richardii* is fairly generally distributed. It was collected in and around Scarborough, at Store Bay and at Speyside. It appeared to have a liking for coconut trees. When disturbed the anoles would run right up the coconut trees to the crown. This anole is known as "gumangalá"; this is the only Caribbean island in which I have met a genuine vernacular name for the common tree lizards which may be seen anywhere. I was puzzled by the apparent absence of the two Trinidad forms. I looked most carefully around clumps of trees and in old buildings in Scarborough without discovering any suggestion of the presence of another species.

Discussion

These anoles show well the dual influence of the Greater Antilles and South America on the fauna of the Lesser Antilles. I regard the evidence as fairly good that the *bimaculatus* group, of Greater Antillean affinities, extends no farther south than Dominica. Complementary to this, we see the extension of the *roquet* group as far north as Martinique. There is every reason to believe that anoles disperse readily; I am therefore at a loss to explain why the two groups do not overlap. Further collecting may show that either Dominica or Martinique does in fact possess two stocks of anoles. I find it difficult to believe that competition has excluded a second species from either of these two islands. On a single tree in Jamaica I have seen four species of anoles, and a total of six species in one group of trees.

The distribution of *Anolis wattsi* through the Leeward Islands nicely illustrates the process of colonisation of a group of islands. We have the absence from the southeast and the slight measure of differentiation between the islands as evidence of relatively recent arrival from the west. *Wattsi* should be sought on St. Barthélemy, a poorly known island. It is perhaps genuinely absent from the better known island of Saba. Saba also lacks the almost ubiquitous *Ameiva*; the lack of beaches may make random colonization of this island difficult.

The differentiation of the *bimaculatus* stock within the Leeward Is. suggests that it is old established. West of Guadeloupe the differentiation runs along the sort of lines which might be expected. The stocks on the three islands of the Anguilla bank are closely alike; their separation is probably recent. It is a little surprising that the Saba stock should most closely resemble the Anguilla bank stock; it is however the nearest island to this bank. The St. Eustatius, St. Kitts and Nevis stocks resemble one another, the closest resemblance being between the latter two. On the basis of scanty material the stocks on the two islands of the Antigua bank also resemble one another.

The Leeward Islands consist of two chains: an outer chain of older islands running from the Anguilla bank to Marie Galante

Anguilla		gingivinus				wattsi
St. Martin		gingivinus				wattsi
St. Barthélemy		gingivinus				?
Antigua		leachii				wattsi
Barbuda		leachii				wattsi
Saba	bimaculatus group	sabanus			wattsi group	—
St. Eustatius		bimaculatus				wattsi
St. Kitts		bimaculatus				wattsi
Nevis		bimaculatus				wattsi
Redonda		nubilus				
Montserrat		lividus				
Désirade		sp. nov.				
Guadeloupe		alliaceus	marmoratus	—		—
Les Saintes		terraealtae	—	—		—
Marie Galante		speciosus	—	ferreus		—
Dominica		—	oculatus	—		—
Martinique		roquet	—	—		—
St. Lucia	roquet group	cinereus?	luciae + procuratoris	—		wattsi
Barbados		cinereus	—	—		
St. Vincent		—	vincentii	griseus		
Grenadines		aeneus	—	richardii ?		
Grenada		cinereus	—	richardii		
Tobago		—	—	richardii		
Trinidad		aeneus	trinitatis	—		
		roquet subgroup	trinitatis subgroup	richardii subgroup		

Fig. 3. Distribution of *Anolis* species in the eastern Caribbean (*A. nitens* = *chrysolepis* omitted on Trinidad.)

and an inner chain of younger islands running from Saba through Les Saintes into the Windward chain. The islands of the outer chain were built originally by volcanic activity. These old volcanic islands have evidently been strongly eroded and finally submerged. They then acquired a cap of white limestone and were later thrust up again. The greater part of the visible islands now consists of the fairly flat, moderately eroded, limestone caps. In a few places the old foundations are exposed, notably in the line of hills along the south side of Antigua. The islands of the inner chain have been built entirely by volcanic activity. They are mountainous and rugged and most of them high enough to catch a higher rainfall than the islands of the outer chain.

The island of Guadeloupe is of especial interest in that there the two chains meet; the smaller part, Grande-Terre, is flat and limestone, the mountainous part, Basse-Terre, is rugged and volcanic. They meet along a front of about 4½ km., being separated only by a narrow salt-water channel, the Rivière Salée. To the east is the small limestone island of Désirade and further south Petite-Terre, a group of two or three very small limestone islands. South of Grande-Terre is Marie Galante at the southern end of the outer Leeward chain. South of Basse-Terre is the small volcanic group of Les Saintes.

In relation to its potential interest Guadeloupe is the most neglected island. I have long felt that this island may provide a setting of just sufficient complexity to allow of species differentiation *within* the island in contrast to the usual differentiation *between* the Lesser Antilles. It was therefore gratifying to find, from the examination of preserved material, evidence of the occurrence of two species in the *bimaculatus* group on Guadeloupe. Neither *alliaceus* nor *marmoratus* closely resembles any of the forms in the islands to the northwest. Their strongly contrasting color patterns perhaps serve as recognition characters. I have seen no specimens collected in Grande-Terre and I wonder if this half of the island is not virtually a *terra incognita*. On Marie Galante and Les Saintes are what appear to be rather similar stocks of *speciosus* and *terraealtae*; in their plain greenness they may resemble *lividus* of Montserrat. The very striking *Anolis ferreus* of Marie Galante is, as judged from preserved specimens and on the testimony of Barbour who saw them alive, very similar in color to *speciosus*. The big tail crest is presumably a recognition character. The brown form of Désirarde may very well occur also on Grande-Terre.

If, as we have reason to suppose, the several glacial and interglacial periods were concomitantly periods of falling and rising water level then the two parts of Guadeloupe must have undergone successive conjunction and disjunction. At all times since the island arrived at its present double condition there must have been marked ecological differences between the two parts. To the student of evolution the island provides an almost diagrammatically perfect stage setting for a discussion of the process of speciation.

The geckos of the genus *Sphaerodactylus* and the ground lizards of the genus *Ameiva* are very widely distributed in the Antilles; they show conspicuous differentiation of local stocks. These two genera have been very poorly collected in Guadeloupe and neighboring islands; they may well show interesting patterns of differentiation in this area.

The obscure situation in Dominica clearly calls for further study; such an undertaking will be hindered by the lack of roads. Color pattern similarities between *oculatus* and *marmoratus* in respect of the light speckling, and between *oculatus* and *alliaceus* in respect of the black markings, suggest that it was colonized by a Guadeloupe stock and, possibly, that it has been doubly colonized.

It would seem *a priori* most likely that the three series of the *roquet* group originated in South America. The *roquet* series is known to be represented on the mainland and the *trinitatis* series almost certainly occurs there too. I think that the evidence is good that the *richardii* series is not represented in Trinidad; it is presumably therefore a relict in the islands. If it had differentiated in the islands it would be difficult to explain the close similarity of the Grenadian and Tobagonian stocks unless it had originated in Tobago and spread thence to St. Vincent and (more recently) to Grenada. Settlement of Tobago from Grenada would seem to be very unlikely in the face of the westward ocean drift across northern South America.

The *trinitatis* series misses Grenada on present evidence; this may well however be a collecting artifact; the experience of St. Lucia shows only too clearly that a series of specimens from the capital of a Lesser Antillean island is not sufficient to give a full picture. As matters stand this series presents no puzzling features. However, the fact that it shows geographical differentiation on St. Lucia is noteworthy, and presumably argues that it is not a recent settler there.

The *roquet* series does show some puzzling features. That the Grenada and Barbados stocks resemble one another seems to argue fairly recent colonization from the mainland. That the mainland stock is the most conspicuously differentiated makes this first proposition difficult to defend. The resemblance of the British Guianese to the Trinidadian stock argues that a moderate segment of South America is occupied by this differentiated population. It is perhaps easier to suppose that there have been recent population movements and that there was recently a *cinereus*-like *roquet* stock along the north coast, which may indeed still occur somewhere in South America. The puzzling resemblance of the Grenadine and South American stocks has already been pointed out. That the Grenadine stocks should resemble one another is reasonable for they all stand on the same submarine bank; that they should differ from the Grenadian stock is surprising for it also stands on the same bank. Bearing in mind the situation in St. Lucia the possibility may be suggested that *gentilis* and *cinereus* are to be considered as an allopatric pair of forms on ''Greater Grenada'' (i.e. the Grenada bank territories). The island of Grenada cannot be said to have been surveyed in this regard; both forms may well be found there. All the St. Vincent material which I have seen has come from Kingstown and it cannot be assumed that the *roquet* series has missed this island.

From my observations of *trinitatis* in Trinidad I can believe that it has been overlooked in Tobago. On the other hand, I find it harder to believe that the *roquet* series has been overlooked in Tobago. Tobago is so situated that one can imagine that every Orinoco flood carries material in its direction; perhaps the *roquet* series is not represented in the Orinoco basin.

The surprises and problems which emerge from this somewhat haphazard study make it abundantly clear that each island, most especially Guadeloupe and the Windward islands, deserves a careful survey by someone with a main interest in the anoles. Most of the material has been collected in visits in transit, or by workers who collected lizards incidentally to a main interest in some other field. As small vertebrates go, these anoles are easily collected; they fairly swarm in many parts. As eye-minded animals like ourselves, they show colors and visual display characters which impress us far more than could, say, the odors which are evidently important to many mammals. A situation of considerable biological interest awaits adequate study.

My travel in the eastern Caribbean was made possible by a grant from the Carnegie Corporation; my indebtedness to Messrs. Williams and Shreve I have already stressed; Dr. F. W. Braestrup reported on the only problematical specimen which I did not see myself; Dr. J. Guibé placed material in the Paris Museum at my disposal; Mr. J. C. Battersby extended courtesies in the British Museum and Dr. D. M. Cochran gave me access to material and information in the U.S. National Museum — to all these I am grateful. Latterly I have corresponded with Mr. Gregory Williams to whom I am also indebted for a number of specimens from St. Lucia.

REFERENCES CITED

References for original descriptions are given in the text; only works in which additional data is given are referred to here.

BARBOUR, T.

1930a. The Anoles. I. The forms known to occur on the neotropical islands. Bull. Mus. Comp. Zool., **70:** 105-144.

1930b. A list of Antillean reptiles and amphibians. Zoologica, **11:** 61-116.

COCHRAN, D.

1934. Herpetological collections from the West Indies made by Dr. Paul Bartsch under the Walter Rathbone Bacon Scholarship 1928-1930. Smithsonian Misc. Coll., **92:** 1-48.

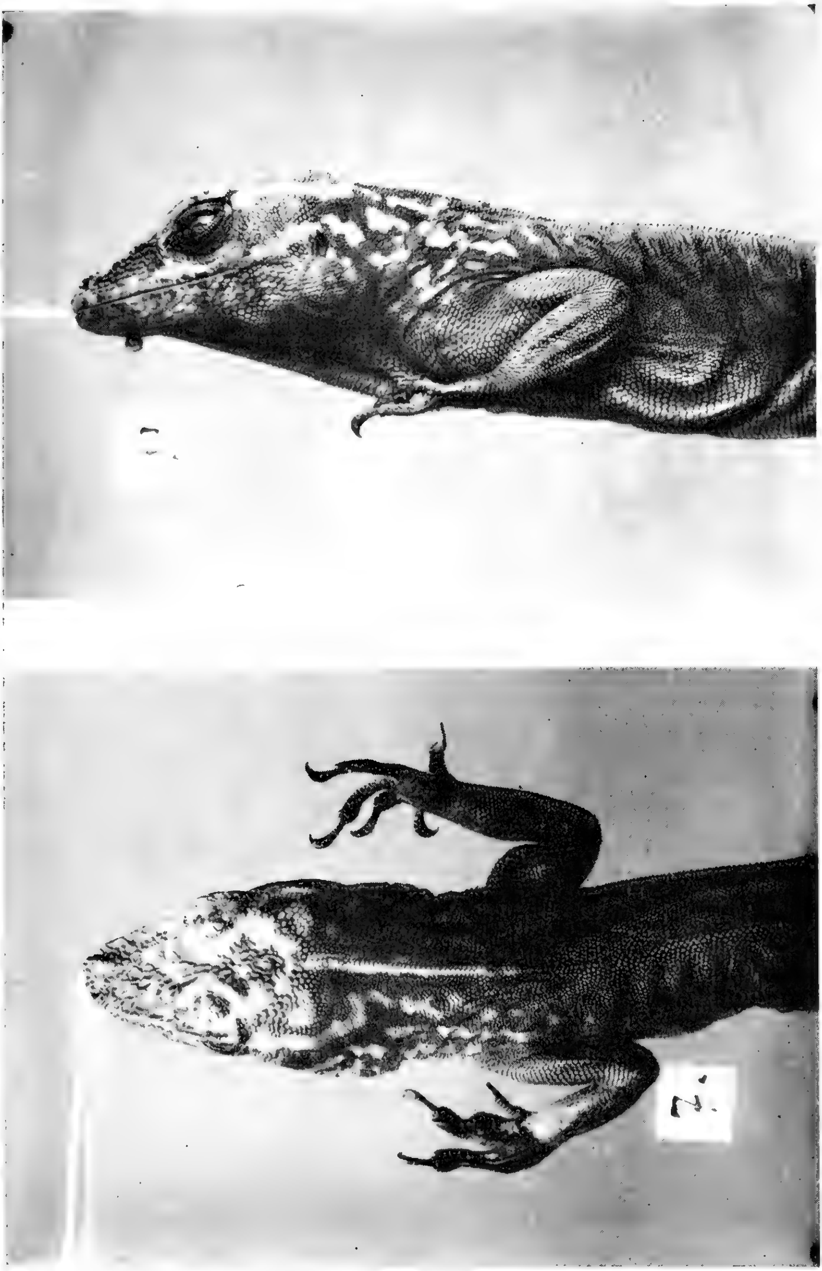
1938. Reptiles and amphibians from the Lesser Antilles collected by Dr. S. T. Danforth. Proc. Biol. Soc. Washington, **51:** 147-156.

DOFLEIN, F.
1908. Uber Schutzanpassung durch Ahnlichkeit. (Schutzfärbung und Mimikry.) Biol. Centralbl., **28:** 243-254.

GARMAN, S.
1887. On West Indian Iguanidae and on West Indian Scincidae in the collection of the Museum of Comparative Zoology at Cambridge, Mass., U.S.A. Bull. Essex Institute, **19:** 28-54.

PLATE

The type of *Anolis marmoratus* Duméril and Bibron. Lateral and dorsal views. Courtesy of the Paris Museum.



PLATE

Bulletin of the Museum of Comparative Zoology
AT HARVARD COLLEGE
Vol. 121, No. 6

ON A TAXONOMIC PUZZLE AND THE CLASSIFICATION OF THE EARTHWORMS

By G. E. Gates
University of Maine, Orono

CAMBRIDGE, MASS., U.S.A.
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No. 6 — *On a Taxonomic Puzzle and the Classification of the Earthworms*[1]

By G. E. Gates

The puzzle is provided by earthworms belonging to an undescribed species, secured by an anonymous collector at an unknown site. Fortunately, a dozen specimens, more than have been studied in many species, are available. These worms must have been unusually well preserved originally, but their present condition calls attention to the necessity of discovering ways of preventing deterioration in museum material.

The difficulties encountered in trying to place the new species in the "classical system" of the Oligochaeta called attention once more to the need for a critical examination of the nature of that classification. This is undertaken in the discussion.

DESCRIPTION

External characteristics. Length, 450-500 mm. Diameter, 7-8 mm. Pigment unrecognizable (alcoholic preservation probable). Prostomium epilobous, tongue short and open (3 specimens) or closed (1 specimen), combined pro- and epilobous (1 specimen), seemingly proepilobous (1 specimen), indeterminable (6 specimens). Setae, eight per segment and present from ii, rather closely paired, ventral couples (and also follicle apertures) of xvii-xix usually unrecognizable, in front of clitellum AB a trifle smaller than CD, $BC <$ or $> AA$, DD ca. = ½C. Nephropores unrecognizable and microscopic. First dorsal pore at 8/9 (2 specimens), ?9/10 (4 specimens), 9/10 (6 specimens).

Clitellum, saddle-shaped, reaching ventrally to B, intersegmental furrows obliterated, dorsal pores not occluded and presumably functional, setae probably present but deeply retracted and exceedingly difficult to recognize, on (xiii?)xiv-xix(xx? 1 specimen), (xiii?)xiv-xx (1 specimen), xiv-xix (2 specimens), xiv-xx (8 specimens).

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[1] The discussion of classification is from a manuscript, written during tenure of a John Simon Guggenheim fellowship, 1952-1953, but with such minor changes as were required to bring it up to date, March 1959.

Spermathecal pores minute, superficial, at or slightly median to *B,* slightly in front of or on segmental equators, two pairs, in viii-ix. Female pores at or slightly lateral to *A,* about equidistant from 13/14 and eq/xiv or slightly nearer 13/14. Male pores minute (each on a very small tubercle at eq/xviii?). Prostatic pores minute, two pairs, in *AB* at eq/xvii and eq/xix. Seminal grooves nearly straight or slightly concave laterally, between eq/xvii and eq/xix, at or slightly median to *B,* deep and wide (i. e., not mere linear furrows), containing male pores and with prostatic pores at the ends. Each groove is within a protuberant, longitudinally elliptical area (of epidermal thickening?). A deep slit-like crease at mV crosses all of xvii-xix, reaching into xvi (2 specimens), through xiii (1 specimen).

Genital markings unpaired, transversely placed, presetal, in *BB,* on xx and xxi (12 specimens). Additional markings of the same sort as follows: on xv-xvi (2 specimens), xvi (1 specimen), xv, xvi and xxii (1 specimen), xvi and xxii (3 specimens). A central portion of each marking is greyish and translucent.

Internal anatomy. Septum 5/6 funnel-shaped, slightly strengthened and translucent, 6/7-10/11 thickly muscular. Longitudinal muscle band at mD distinct from level of first dorsal pore or pore-like marking, unrecognizable anteriorly. Pigment unrecognizable in body wall except at mD, the muscle band, in one or more scattered segments or through several consecutive metameres, often dark red. The subesophageal mesentery in x-xiii seems to be slightly strengthened.

Gizzards well developed, lined with thick cuticle, two, in v-vi (12 specimens). Cuticular lining continued from gizzards through viii or ix (at least?). Esophagus widened and moniliform in xi-xiii where there are (internally) closely crowded rather lamelliform but low and vertical ridges as well as a bifurcated ventral typhlosole (12 specimens). Intestinal origin in region of 15/16. Intestinal typhlosole lacking (?).

Dorsal blood vessel single, complete, bifurcating under the brain, the branches passing ventrally and uniting over the subesophageal ganglion to become the ventral trunk. Latter also complete, with two pairs of branches between 4/5 and the anterior bifurcation. Extra-esophageal trunks filled with blood anteriorly and traceable forward into ii, posterior portions unrecognizable, median to hearts. Supra-esophageal trunk present in ix-xiii. Subneural trunk lacking (?). Hearts of x-xiii apparently latero-esophageal though blood is lacking in filamentous branches to the dorsal trunk. Last hearts in xiii (11 specimens). Hearts of ix-vi (all easily traced to ventral trunk), lateral. Hearts of v may pass to ventral vessel on one or both sides but usually are not traceable to that trunk. Brain in ii or in iii.

Excretory system meronephric. Astomate micronephridia cover body wall in (ii?)iii-iv. At least from iv the number per segment decreases, to 40-50 in x, the small astomate tubules in the latter metamere and posteriorly in a row just in front of the septum and from region of *A* nearly to mD. Several nephridia are crowded together at the median end of a row but as far back as tubules are distinguishable all are astomate.

Holandric (12 specimens). Male funnels, and presumably also testes, free in x-xi. Male deferent ducts slender, becoming unrecognizable shortly behind funnel septa and after passing to parietes. Seminal vesicles medium-sized or smaller, finely acinous, low down in coelomic cavities, two pairs, in ix and xii. Prostates medium-sized, flat discs, racemose,[2] two pairs, each usually extending through three segments, usually three to six levels behind xvii or xix with their ducts passing anteriorly through septal perforations, occasionally in xvi-xvii and xviii-xx, once seemingly confined to xvii and xix but bulging septa far posteriorly. Duct slender but probably muscular, 4-6 mm. long.

Spermathecae fairly large but not reaching dorsal parietes, always bound to anterior septum of their segment by fairly strong tissue from which the ectal half of the duct is free. Duct slender, probably muscular though sheen no longer recognizable, slightly widened entally but an appearance of even greater widening is due to presence of one or two very short loops bound closely together. Seminal chamber ellipsoidal, sessile vertically on entalmost portion of duct into which it opens entally by a single aperture.

GM glands represented by clusters of several very small spheroidal bodies, the clusters always covering the parietes over sites of genital markings except in two specimens with least obvious clitella and in which the little glands may not have

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[2] Without a central lumen. (Sections have been deposited in the Museum of Comparative Zoology.)

reached definitive size. (These glands, in some of the specimens, are not easy to distinguish from the nephridia.)

Ventral follicles (*a* and *b*) of viii, ix, xvii and xix, completely buried within the parietes, contain setae that are much slenderer and shorter than those of neighboring segments. Shafts of these smaller setae are straight and taper ectally but not to a sharp point. Ornamentation on the penial setae, as those of xvii and xix presumably should be called in spite of their small size, is of several (four?) longitudinal rows of four or five excavations. Each pit is long, narrow, deepened entally where its floor is finely nodose. Excavations on the copulatory setae (*a* and *b* of viii-ix) are of the same sort but more numerous, in longitudinal rows of seven to nine. Ectalmost pits are closer to the tip than on the penial setae but ends of copulatory setae may have been subjected to more erosion. Ventral setae of xviii appear to be lacking as their follicles were not found.

Reproduction. Iridescence on male funnels of each specimen (including the aberrant one) proves that sperm had been matured. A similar iridescence in the spermathecal seminal chambers of each worm shows that copulation had taken place. Reproduction, accordingly, is assumed to be sexual and biparental.

Ingesta. The gut of each worm is filled with a sort of humus in which plant parts or tissues are not distinguishable. Little or no sand and clay is present. These worms appear to be discriminating feeders.

Abnormality. Organs of right side belonging in viii-xix are (1 specimen) one segment anterior to their normal location: spermathecal pores on vii-viii, female pore on xiii, prostatic pores on xvi and xviii, last heart in xii, testes in ix-x, seminal vesicles in viii and xi, etc. The clitellum is on xiii-xx on both sides. Both hearts of ix are lateral.

Presumably a mesoblastic somite at the seventh level (or anteriorly?) was aborted early in development.

Remarks. The worms may have been quickly killed and properly preserved. Unfortunately, however, subsequent care had been lacking and all are macerated, especially from region of xxiii to hind end. The size of properly preserved, contracted specimens is estimated to be between 150-250 x 9-10 mm. Locations of prostatic pores were confirmed by dissecting prostatic ducts out of the body wall. Location of male pores, inasmuch as vasa deferentia cannot be traced, requires confirmation. No evidence was found to indicate junction of those gonoducts with the prostatic ducts. Some of the seeming variation in antero-posterior extent of the clitellum may be due to incomplete development as the tumescence, in several of the specimens, is slight. The intestinal wall had been reduced to a transparent slime in which caeca and supra-intestinal glands might not have been recognizable. A typhlosole, if present, should have been distinguishable as a lamella of slime extending down into gut contents. When a typhlosole is absent supra-intestinal glands usually are lacking. Complete relaxation of the esophageal valve in each specimen, along with the maceration, obviated determination of site of intestinal origin which is unlikely to be variable, except as a result of some aberration in embryonic development.

Characterization of excretory organs behind xxx is impossible. If nephridia are exonephric throughout the body all may be small and astomate as in *Octochaetoides*, or the medianmost on each side of some posterior segments may be larger (as in various octochaetine genera) and provided with a preseptal funnel. Although less likely perhaps, some or even all of the micronephridia, along a major posterior portion of the axis, may be enteronephric and stomate. Presence in posterior segments of one to several pairs of large, stomate, enteronephric nephridia is not anticipated.

Uniformity in number of prostates and in relation of their external apertures to the male pores among so many specimens, even including one that is aberrant, seems to warrant an assumption that the arrangement of the male terminalia is characteristic of the species to which these worms belong. An ''acanthodriline'' arrangement of racemose prostates has been unknown hitherto and requires, in the Oligochaeta where a single character rarely is diagnostic at any taxonomic level, erection of a new genus.

Although diagnosis is assured, determination of relationships must await much more adequate description of digestive, vascular and excretory systems than is permitted by available material. Some generic characters cannot, of course, be recognized when only one species is known. Intestinal origin, for instance, is uniform in some genera, possibly even throughout one family (Lumbricidae), but is subject to individual variation in the Moniligastridae. A typhlosole is lacking in some genera and even throughout one family (Moniligastridae), but is now known to be absent only in some of the species of several genera. Number of gizzards is uniform in some genera and subfamilies, but in the Moniligastridae is subject to individual variation. Andry, in spite of the reliance placed on it in the classical system, does vary intragenerically, sometimes even intraspecifically. Hence, the definition below is tentative. In fact, any generic definition must be considered liable to revision, at least until all species have been satisfactorily described. A definition certainly does not become sacrosanct through publication in a thick monograph. Yet species, genera, even one family, have been erected because of unimportant difference from one or more characters as stated in definitions.

Taxonomically important characters that are unknown or in need of confirmation, in accordance with previous practice, are indicated below at specific as well as generic level.

Genus EXXUS gen. nov.

Definition. Quadriprostatic, prostates racemose and of pheretima sort but with ducts opening externally at equators of xvii and xix. Male pores (in seminal grooves that extend from eq/xvii to eq/xix) at eq/xviii (?). Setae, eight per segment and paired (throughout?).

Gizzards in v-vi. (Intestinal origin in xv?) Calciferous glands (typhlosole, intestinal caeca and supra-intestinal glands?) lacking. Vascular system with complete (single) dorsal trunk, with extra-esophageal trunks median to hearts, with a supra-esophageal trunk in ix-xiii but without a subneural(?), (lateroparietal trunks?), and with latero-esophageal hearts in x-xiii. Excretory system meronephric, nephridia astomate and exonephric (throughout or enteronephric in iii-iv?), massed on parietes in iii-iv, but posteriorly — on each side of each segment — in a transverse row, extending from *A* nearly to mD just in front of the septum.

Type species. Exxus wyensis sp. nov.

Precis of E. wyensis. Quadrithecal, spermathecal pores minute, superficial, two pairs, at or slightly median to *B*, on or slightly in front of segmental equators, in viii-ix. Female pores at or slightly lateral to *A*, about midway between 13/14 and eq/xiv. Male and prostatic pores minute and superficial. Genital markings unpaired, in *BB*, presetal, on xx and xxi, often with one or more similar markings in some of xv-xvi, xxii. Setae, rather closely paired, *DD* ca. = ½C (throughout?), ventral setae of xviii lacking at maturity (?), *a* and *b* of xvii and xix (penial) as well as of viii-ix (copulatory) concealed in small follicles within parietes and ornamented ectally by several longitudinal rows of narrow pits that are deeper entally and there with a nodose floor. Clitellum, saddle-shaped, on xiii, xiv-xix, xx. First dorsal pore at 8/9 or 9/10. Prostomium, epilobous(?). Pigmentation, red(?). (Segments?) Size, 150-250 by 9-10(?) mm.

Septa 6/7-10/11 thickly muscular. Atyphlosolate(?). Intestinal origin in xv (?). Holandric. Seminal vesicles, small, acinous, two pairs, in ix and xii. (Ovaries fan-shaped and with numerous egg strings?) Spermathecae medium-sized, each with a vertically ellipsoidal seminal chamber sessile on duct near ampulla and opening into duct entally. GM glands small (composite?), numerous, nearly covering parietes over sites of genital markings.

Reproduction. Presumably sexual and biparental.

Distribution. Unknown.

DISCUSSION

One important part of the puzzle mentioned in the title is finding a place for the new genus in the "classical" system of the Oligochaeta. That classification, as presented in the tenth volume of Das Tierreich (Michaelsen, 1900), was regarded as "a triumph of arrangement which brought order into confusion and constituted a remarkable advance in our understanding of the group" (Stephenson, 1930, p. 716), more especially because of the "clear and logical division into subfamilies, *on a phylogenetic basis*, of the large family Megascolecidae" (italics not in original). Few of the various modifications proposed during the last half century (cf. Table 2 and subjoined notes) have been universally acceptable. Accordingly, the classification in the latest monograph on the order, The Oligochaeta (Stephenson, 1930), is recognized, for greater convenience in the ensuing discussion, as a currently terminal stage in development of the classical system.

The new genus clearly belongs in the Megascolecidae, where the male genitalia appear, from the definitions, to be of considerable taxonomic importance. Arrangement of the terminalia in *Exxus* is "purely acanthodriline,"[3] i. e., there are two pairs of prostates having apertures at equators of segments xvii and xix but with the male gonoducts opening typically to the exterior on xviii midway between the other pores. Acanthodrilin terminalia are allowable in the Acanthodrilinae, Ocnerodrilinae, Diplocardiinae and Octochaetinae, but the genus cannot go in either of the first three subfamilies where, by definition, prostates must be tubular. Inclusion in the Octochaetinae at first does seem permissible as prostates are not mentioned in the definition. The omission probably was unintentional as all genera do have tubular prostates and Michaelsen (1900, p. 319) did specify "Prostaten schlauchförmig." Glands of the racemose kind found in *E. wyensis* are permissible in the last remaining subfamily where the prostates are "tubular or racemose (pheretima prostates)." Those organs, however, by definition, are limited to one pair "with each prostatic duct uniting with the vas deferens of the same side and opening in common with it (except in *Diplotrema*)" on xviii. The exception provides no loophole as prostates in *Diplotrema* are tubular and their pores, though discrete, are on xviii, close to the male apertures.

Erection of a new subfamily for a single species, in spite of all those difficulties, seems unwarranted, in which case modification of the classification becomes necessary. Any *ex tempore* changes, solely for accommodation of one troublesome form, might later prove to be as ill advised as some of those proposed during the last forty years. Accordingly, a review of the entire classical arrangement of the Megascolecidae seems advisable and this can begin appropriately with an examination of family and subfamily definitions.

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[3] Various patterns of morphological organization long have been characterized as lumbricine, microscolecine, etc., though none are diagnostic of the named subfamilies and some are common to several families. The adjective designating pattern is hereinafter distinguished from that for a subfamily by omission of the final vowel.

Megascolecidae (*cf.* Stephenson, 1930, p. 818). The definition comprises eight sentences. One and parts of two others are unqualified. "Setae sigmoid, single pointed," correct, but equally applicable to all earthworm families and some Microdrili. "One pair of male pores," not universally true throughout the family, as two pairs of male pores are present in species of *Hoplochaetella,* and, in several subfamilies, parthenogenetic strains have no male pores. "One pair of ovaries in xiii.," true of most families of earthworms but here inadequate. Ovaries in one genus, possibly two, are always in xii and at least one species (of *Diplocardia*) has two pairs of ovaries in xii-xiii. Other parts of the definition are qualified, by "usually," "rarely," exceptions or alternatives. One such statement, "Two pairs of testes in segments x and xi, or one pair only, in x or xi" is equally applicable to the Eudrilidae, Glossoscolecidae, Lumbricidae and the microdrilin Haplotaxidae, but is actually inadequate for the Megascolecinae which contains one genus, possibly two, with testes in ix and x. Each of the characters mentioned in the definition is found in various other families, hence none (at least as stated) is diagnostic.

Acanthodrilinae (*idem,* p. 820). Two statements are unexceptional: "Meganephridial. Prostates tubular." Neither is diagnostic, tubular prostates being common in each of the sister subfamilies as also are "meganephridia." The latter term, in its literally descriptive meaning, has no taxonomic value at family or subfamily levels. Redefining the word is unnecessary, as an accurately descriptive term, holonephric (or holonephridial), is available. Other characters mentioned in the definition are qualified by "mostly," "more or less," or are in pairs of alternatives, sometimes even with qualifications. None of the characters, with or without qualification, is diagnostic, being equally applicable to sister subfamilies, other families and even some Microdrili.

Megascolecinae (*idem,* p. 828). Two characters here also are stated without qualification: "Male pores on xviii. Prostates one pair." Neither is diagnostic, each being applicable at least to some portion of the other subfamilies. Although male pores may sometimes be on xviii in other families they are by no means universally so in the Megascolecinae. In one genus, perhaps two, the pores are always on xvii, in another they may be on xvii, xviii, xix or xx; in *Plutellus* they may be on xviii, xix or xx. Number of prostates in some megascolecine species is subject to individual variation. In *Pheretima posthuma* as many as three pairs have been found. Other statements in the definition, even with all their qualifications are inadequate. ''Usually one gizzard in front of the testis segments, sometimes two or three, exceptionally none,'' should read somewhat as follows: Gizzard lacking, single, in a single segment or in a space formed by abortion of one or more septa, or double or triple, in front of testis segments, or one in front of testis segments and several more behind. Similarly, ''Spermathecal pores, if present, one to seven pairs, in front of testis segments'' should be: Athecal or thecal and then spermathecae usually in front of testis segments, rarely in or even behind those segments, pores unpaired, paired, in pairs of pairs or in pairs of groups.

Octochaetinae (*idem*, p. 841). No statements unqualified and no character diagnostic. The prolixity of one characterization, ''Excretory system of meganephridia along with micronephridia or micronephridia alone, the latter never having the form of sacs'' can be avoided, with considerable gain in taxonomic accuracy, by use of three words: Excretory system meronephric.

Diplocardiinae (*idem*, p. 849). Two unqualified statements. Both are applicable to sister subfamilies, one to other families. No character is diagnostic.

Ocnerodrilinae (*idem*, p. 852). Three unqualified statements, two being the same as in the definition of the Diplocardiinae; the third is ''Meganephridial.'' Characterization of the calciferous section of the gut should, strictly speaking, exclude an important section of the subfamily containing two of Stephenson's genera. This was, however, avoided by interpreting certain microscopic spaces in the esophageal wall as vestiges of paired extramural calciferous glands.

These definitions, which contain no diagnostic characters, do not define but merely list some of the more obvious or better known structural diversities of a group, and now appear to have resulted from construction of the classification ''on a phylogenetic basis.'' Morphological changes that mean anything from the evolutionary point of view, according to Stephenson, are few. We know, continues the argument, which characters are primitive and which are secondary. The principal pairs or groups of primitive-secondary characters are: One gizzard — multiple gizzards. Lumbricin setae — perichaetin setae. Holonephric — meronephric. Tubular prostates — racemose prostates. Acanthodrilin genitalia — microscolecin, megascolecin, balantin genitalia. Characters of lesser importance are: Calciferous glands absent — calciferous glands present. Holandry-proandry, metandry. Hologyny-progyny, metagyny. Those are just the characters by which megascolecid genera were defined. Genera so characterized could then be arranged serially in evolutionary lineages of a mother-daughter-granddaughter sort. The amazing result of the filiations was a phylogenetic tree with all of the stages in the evolution of the subfamilies still available for investigation, "a living paleontology — as if students of the Equidae had all the stages in the ancestry of the horse alive before them today." Correctness of the filiations was "proved" by forms that were found to be transitional between mother and daughter genera.

Since anatomical changes that amount to anything from an evolutionary point of view are so very few, convergence is frequent in the Oligochaeta. Perichaetin setae, for instance, have appeared in the Acanthodrilinae, Octochaetinae, Megascolecinae and in the Glossoscolecidae, meronephry in various megascolecine lines of descent as well as in the Diplocardiinae and the Octochaetinae, calciferous glands in all megascolecid subfamilies (even including the Acanthodrilinae) and also in the Glossoscolecidae and Lumbricidae. Necessarily, convergent genera resulted. The diplocardiine *Monogaster* of tropical Africa was distinguished from the octochaetine *Octochaetus* of Pacific areas only by its distribution as the "definitions of the two genera are the same." Similarly, distribution distinguished the acanthodriline *Udeina*[4] of South Africa from the megascolecine *Plutellus* of Pacific areas. Nor is the convergence always as simple taxonomically as in those two instances, for genera may be polyphy-

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[4] The terminalia were erroneously characterized and are not megascolecin as Pickford (1937) later discovered. The two species of *Udeina* may have arisen independently from different species groups of the acanthodriline *Parachilota*, according to Pickford (1937), by changes that now appear to be relatively unimportant and of dubious value for generic distinction.

letic. *Megascolex,* the best example, evolved from *Perionyx, Spenceriella* and two different sections of *Notoscolex.* In that case as well as in others, anatomy permitted recognition of diverse origins but how much polyphyly would remain morphologically or geographically undetectable was beyond estimation. Acquisition of further data occasionally might enable resolution of a fraction of the polyphyly, but usually Stephenson seems pessimistic about taxonomic boundary lines. They are ''bound to be merely arbitrary'' (1923, p. 193), and ''since all such lines are arbitrary interruptions in the record of a continuous process'' (1930, p. 833) it does not matter very much where they are drawn. Convenience, presumably of the systematist, was the criterion employed in various cases.

No comment seems necessary as to sequence in some of the pairs or groups of primitive-secondary characters. The acanthodrilin male terminalia, however, may not always have been ancestral to the other kinds and, like some of them, may have been derived from a more ancient (and possibly less uniform?) arrangement. The prostate sequence certainly requires consideration. The pheretima kind lacks a central lumen throughout and the duct may even branch outside of the gland. Supposedly intermediate sorts of racemose prostates, having a central lumen into which more or less definite lateral canals open, really are tubular. The pheretima prostate develops ontogenetically (Stephenson and Ram, 1919) from peritoneal proliferation and acquires an external aperture by growth outward through the body wall. Tubular prostates, on the contrary, are epidermal invaginations (Pickford, 1937) — as can be seen in dissections of juveniles. Gradual evolution of an ectodermal ingrowth into a mesodermal outgrowth, especially in animals with a determinate embryology, is difficult to visualize and now appears improbable. Megascolecin terminalia, those in which male gonoducts unite with the ducts of a single pair of ectodermal or mesodermal prostates to open externally, through one pair of male pores on xviii, accordingly provide another but hitherto unrecognized example of convergence. The ''arbitrary'' selection of such terminalia as the distinguishing character of a subfamily produced an otherwise undefinable and markedly polyphyletic group.

Delimitation of other megascolecid subfamilies, it may here be noted, was no more fortunate. Selection of a form with extramural and paired calciferous glands in ix and x as the initial stage in ocnerodriline evolution necessitated deriving the unpaired condition in *Curgiona* and *Gordiodrilus* by fusion midventrally of paired sacs, and interpreting microscopic spaces in the esophageal wall of Indian genera as rudiments of retracted extramural glands. Both derivations seem improbable. The Diplocardiinae, in which the initial evolutionary stage was duplication of the gizzard, has gradually disappeared (*cf.* note 6, Table) into the two remaining subfamilies. The more recent, the Octochaetinae, with endemic genera in New Zealand, India, Africa and the Americas, now appears (Gates, 1958b) to be polyphyletic. The older Acanthodrilinae comprises the phylogenetic ''brushwood'' that was left over from delimitation of sister subfamilies. The group does seem to have some little common anatomy, but the wide discontinuities in its distribution (New Caledonia, Australia, New Zealand, the Americas, Africa, Madagascar, Cape Verde and Subantarctic Islands), especially if earthworm evolution is limited (Stephenson, 1930) to the Tertiary and Quaternary, suggests polyphyly.

Delimitation of megascolecid genera in the classical manner has proved to be even more unsatisfactory. On various occasions, since 1900, Michaelsen himself shifted generic boundaries back and forth, or abolished them. As for the Acanthodrilinae, Benham could not agree with Michaelsen, and after her study of the group Pickford differed from both of them. On megascolecine demarcations, Stephenson disagreed with Michaelsen, and Gates could follow neither. In the Ocnerodrilinae, Michaelsen's treatment of boundaries that left *Gordiodrilus* another waste-basket of phylogenetic ''brushwood'' has been questioned (Gates, 1942). More recently (Gates, 1957b) validity of some hitherto undisputed demarcations was challenged. In the Octochaetinae, several lines (Gates, various publications) had to be changed, and now (Omodeo, 1958) two genera have been resurrected (as well as a subfamily) from synonymies, where they had been buried for 60 years. Many more changes can be expected and especially — if the past provides any basis for prophecy — whenever a group is studied by another person. Accordingly, further consideration of individual areas of controversy may well be left to the future.

Hitherto undisputed boundaries do, however, require some comment. Andry, for instance, is not mentioned in definitions of octochaetine as well as most megascolecine and diplocardiine genera. The three standard characters had been found to have taxonomic value only at species level. All acanthodriline and most ocnerodriline genera, on the contrary, are defined by andry which also has considerable importance in the basic phylogenetic esoteries. Even supra-generic groups, in the Acanthodrilinae, are defined by andry. *Nematogenia,* hitherto meroandric by definition, now includes (Gates, 1957b) a holandric species. Holandry and marked hyperandry each have been found in many individuals of a species of *Pheretima,* holandry and anandry in another species of that genus. Holandry, proandry, metandry, hyperandry, anandry, all have been found in worms with genital and somatic anatomy that require the lot to be in one and the same species. Individuals, if not also species, sometimes are morphologically holandric though functionally meroandric.

Standard characters of the male terminalia, in six non-megascolecine genera, were allowed taxonomic value only at species level. Other genera in the Acanthodrilinae, Octochaetinae, Diplocardiinae and Ocnerodrilinae, on the contrary, were delimited from each other by their terminalia to which again considerable importance is attached in phylogenetic esoteries. *Microscolex georgianus* is supposed to have acanthodrilin terminalia, but the posterior pair of prostates fails to develop in an occasional individual which is then microscolecin. Aprostatic individuals have been found in one species of *Diplocardia.* Variation as to number and segmental location of prostates has been found in species of several ocnerodriline genera. More data of similar sorts and from various subfamilies can be expected when efforts are made to study individual variation on a significant scale.

All of the male genitalia now appear to be liable to rapid or abrupt and perhaps macromutational modification. Accordingly, status of genera presently distinguished from each other by andry and/or characters of the terminalia only is dubious. Such genera will have to be united if good evidence to the contrary — preferably from somatic anatomy — is not forthcoming.

The least departure from the very common and ancient lumbricin arrangement of setae constitutes (as Stephenson maintained) a definite and natural line of demarcation. But, of what taxonomic value? The change has been made in one glossoscolecid subfamily and probably on more than one occasion in each of the megascolecid subfamilies except the Ocnerodrilinae. In every instance the extra setae presumably first appeared in individuals of one or more species of a good (*i. e.,* natural or monophyletic) genus, as now seems to have happened in the glossoscolecine *Periscolex.* Somatic anatomy, in that taxon, must have obviated a generic division according to setal numbers. A natural boundary in an evolutionary process can then be placed arbitrarily in a classification as would have been the case if *Periscolex* had been split in the same manner as some of the Megascolecinae. Such arbitrariness now seems to have been responsible for part of the much discussed megascolecine polyphyly. Investigation of somatic anatomy is expected to show that *Megascolex,* as well as several other megascolecine taxa, are quite unnatural congeries, resolvable into morphologically homogeneous and monophyletic genera.

The digestive system provided two classical sets of standard characters. One of the organs, the gizzard, is not homologous throughout the Oligochaeta. Much of the argument over that structure early in this century was about taxonomic value of presence or absence of a single esophageal gizzard. Intermediate stages, characterized as weak, feeble, rudimentary and vestigial, had been found where they were not expected. Agreement that presence or absence is unreliable as a generic character was nearly reached, but Michaelsen's opinions changed more than once. Segmental locations were not always mentioned in descriptions of species and those recorded occasionally have been thought subsequently to be wrong. Whether such errors have been responsible for any of the supposed intrageneric variation in location remains to be discovered. Transfer of a single esophageal gizzard into the segment next behind has been believed to be gradual, but for such change there is very little good evidence. That usually mentioned is insertion of a thin septum at or near the middle of a gizzard. The funnel-shaped septum has been found (in most cases that have been checked) to be inserted behind the gizzard, though adherent to a posterior portion of it in strongly contracted specimens.

With increase in number, gizzards abruptly acquired taxonomic importance at generic and subfamily levels. The digastrin subfamily, however, was gradually disbanded, and Michaelsen seems to have concluded that a third gizzard was inadequate to distinguish *Eutrigaster* from *Dichogaster*. *Eutrigaster* was retained by Stephenson (1930), as was *Perissogaster* which, by definition, differs from *Digaster* only in possession of a third gizzard. Presence of a third pair of spermathecae, again by definition, is all that distinguishes *Didymogaster* from *Digaster*. That difference, *per se*, certainly does not warrant generic distinction as the spermathecal battery seems to be subject to nearly as rapid evolutionary modification as the male genitalia. All three genera, restricted to a small section of Australia, are distinguished from *Notoscolex*, according to their definitions, only by the multiple gizzards. An extra gizzard, by itself, scarcely seems to provide more justification for generic distinction than does the presence of an extra pair of setae. Considerable intraspecific variation in location and number of gizzards has been found in the moniligastrinae. Assumptions as to specific and generic uniformity of those characters in the Megascolecidae usually are unsupported by data obtained from more than a very few specimens. Pending acquisition of much more information, the taxonomic value of gizzard number and location (the only macroscopic characters the organ can supply) remains uncertain.

Calciferous glands were allotted a wide range of taxonomic values in the classical system. The organs, though sometimes present, are not even mentioned in definitions of Acanthodriline and Megascolecine genera. In other subfamilies the characters used in definitions are mainly segmental location and number. The latter often is erroneous. *Dichogaster,* by definition, has three pairs of calciferous glands. Yet, a group of common and widely peregrine species (Gates, 1942, 1958b) really has only one pair. *Howascolex* became even more of a congeries, after 1930, and by definition now has "Calciferous glands either as mere swellings of the oesophagus in segm. 14, with or without a slight development of the same kind in the neighbouring segments; or well developed calciferous glands in segm. 14 and 15, or in segms. 8-11.'' *Diplocardia,* by definition, lacks calciferous glands, though a species was known to have one of a highly specialized sort. The North American genus provides (apparently within the limits of a monophyletic taxon) a beautiful series of evolutionary stages (Smith, 1924), beginning with absence of calciferous lamellae and ending with an intramural gland very similar to that of the better known Lumbricidae.

The standard characters of the remaining somatic sequence are meganephridial and micronephridial. Meganephridia may be holonephric, meronephric, exonephric, enteronephric, vesiculate or avesiculate, with or without a bladder-like caecum, of various sizes and occasionally smaller than some micronephridia, one to several pairs per segment or more numerous. Micronephridia may be stomate, astomate, exonephric, enteronephric with respect to pharynx or to intestine, vesiculate or avesiculate, several pairs per segment up to ''forests'' of hundreds. The standard characters obviously have little meaning in an important sector of somatic structure. Holonephric and meronephric have relegated the older terms to infrequent but more precise usage. They do characterize groups of genera or larger units more accurately than their predecessors, but even so they can have very little of the taxonomic value allowed the older pair in the classical system.

The first appearance of meronephry undoubtedly constitutes a natural and definite line of division in organ evolution but initially can provide no more justification for generic separation than addition of a few setae. Increased knowledge of somatic anatomy can be expected to reveal, in good genera, earlier stages of meronephry than have been recognized hitherto.

More ancient meronephric systems, as an interesting and important series of contributions by Bahl (1919-1945) shows, are organized in a variety of dissimilar ways. A somewhat different sort of organization is less satisfactorily described (Gates, 1943) because of poor preservation. Existence of other kinds of meronephric systems is indicated by the literature. For some time it has been quite obvious that dissimilarities in structure, as well presumably as in embryological development and phylogenetic evolution, are such as to require precise characterization at generic level.

Ever since Savigny (1826) amazed his colleagues by demonstrating the existence, in Paris, of many more than one species of earthworm, taxonomic descriptions have been mainly concerned with organs visible to the unaided eye or, in smaller forms, through a hand lens. A few organs, such as prostomium, setae, gizzard and segmentally paired holomeganephridia, doubtless were the structures seen in the juveniles, that often must have been examined. With increased knowledge, inability to find ''segmental organs'' became acceptable proof for existence of a micronephridial excretory system. Mature worms, however, provided the taxonomist a clitellum of diverse lengths, circumferential extent and location, an array of other epidermal modifications collectively designated as genital markings, genital pores in various locations, a battery of spermathecae, another of seminal vesicles permitting deduction of andry when male gonads were unrecognizable. Mature exotic material that increasingly became available, provided prostates of various sorts, as well as a bewildering variety in other genitalia. On the contrary, guts, blood vessels and nervous system may well have seemed to be tediously uniform. The diversity of genital structure was still far from complete elucidation during the period when Michaelsen (1900) was completing his masterpiece. The conclusion that ''The sexual organs are the most important of all for systematic purposes'' (Stephenson, 1923, p. 7) may have seemed unavoidable. Peremptory denial of evolutionary value (apparently equated in a phylogenetic classification with taxonomic value) to so much of the somatic anatomy, is unlikely to have stimulated investigation of it. Interesting characteristics of the vascular system in little known species were observed by Benham but being of ''no taxonomic importance'' they were not recorded. Inclusion in a taxonomic contribution of information about blood vessels and hearts in several genera of a little known family, even in 1930 seemed so unusual that it was mentioned in Stephenson's monograph.

Study of the octochaetine *Eutyphoeus* has enabled redefinition of the genus as given in the left column of Table 1. On the right, for comparison, is the classical definition (Stephenson, 1930). Descriptive characterizations, often in the past or still included in generic definitions, are listed after the distribution.

TABLE 1
EUTYPHOEUS

As now defined	*As previously defined*
Biprostatic, pores in region of *AB*, near eq/xvii. Male pores minute, near but behind prostatic pores.	Sexual apparatus purely microscolecine (conjoined male and prostatic pores on xvii).
Bithecal, pores superficial, never minute, at 7/8.	Spermathecal pores, one pair, at 7/8.
Setae paired, arrangement lumbricin.	Setal arrangement lumbricin.
Clitellum annular, on xiv-xvi, intersegmental furrows obliterated, dorsal pores occluded, setae retained.	
Septa 4/5-5/6 with muscular thickening, 6/7-7/8 aborted, 8/9-10/11 thickened, crowded together behind their normal locations, 11/12 approximated to 10/11.	An enlarged esophageal gizzard in a space formed by fusion of several segments.
An esophageal gizzard belonging to vi in space between 5/6 and 8/9. Calciferous glands intramural, longitudinally hemi-ellipsoidal with flat faces mesially, numerous transverse vertical partitions and interlamellar spaces directly communicating dorsally with the esophageal lumen here T-shaped in cross-section, 1 pair in xii. Intestinal origin in xv. Typhlosole terminating with a series of doubly-paired supra-intestinal glands. Unpaired, anteriorly directed, small, midventral caeca one each in a number of consecutive segments in front of supra-intestinal glands.	A pair of calciferous glands embedded in the esophageal wall in xii.
Dorsal blood vessel single. No subneural. Lateroparietal trunks from posterior end of body pass to hind ends of calciferous glands. Extra-esophageal trunks, median to hearts, pass to front of calciferous glands. Hearts four pairs, in x-xiii, last three pairs latero-esophageal.	

As now defined	*As previously defined*
Excretory system meronephric, all nephridia small, numerous astomate nephridia of iii pharyngonephric and apparently in a circumferential parietal band but attached to a tightly-zig-zagged cord, remainder of system exonephric and comprising astomate biramous nephridia which are numerous in next few segments but behind clitellum are in longitudinal ranks, the medianmost nephridium of each side behind supra-intestinal glands somewhat enlarged, saccular and with preseptal funnel.	Purely micronephridial.
Terminal portion of male gonoduct modified to function as a bulbus ejaculatorius.	
Spermathecal diverticula open into ental end of short duct.	
Metagynous.	
Distribution: Burma, from Tenasserim division and western margin of Shan plateau into the Gangetic Plain and through the Himalayas to beyond Nepal.	India, especially the Gangetic Plain.
Segments more than 150.	
Unpigmented or pigmented and then with dorsum brown, occasionally green but with no corresponding pigment recognizable.	
Ventral setae of xvii lacking or penial.	
Male and prostatic pores as well as apertures of penisetal follicles in two slight fissures, each with a superficial porophore or more or less deeply invaginate, vestibula paired or unpaired and median, sometimes with protrusible penes.	
Lateral intestinal caeca lacking, rudimentary and/or sporadic, or one pair.	

As now defined	*As previously defined*
Holandric or meroandric. Seminal vesicles in ix and/or xii. Coelomic cavity of xi gradually reduced to an annular, then a U-shaped and eventually a subesophageal testis sac.	Holandric or metandric.
Two female pores, or right oviduct functionless or atrophied.	

The revised definition contains no alternatives and no exceptions. Absence of variation with regard to the characters mentioned, in normal specimens, was determined (Gates, in press) from external examination and dissection of hundreds of specimens. The reproductive system, not excluding the female gonoducts, has undergone considerable modification during intrageneric evolution. The genitalia, from an evolutionary point of view, are not conservative. Much somatic anatomy, on the contrary, has remained uniform during a period in which the genus was spreading through rain-forests and semi-deserts, from tropical lowlands to Himalayan heights.

Eudichogaster, the parent genus of *Eutyphoeus* in the classical system, when redefined (Gates, 1939, 195?) with reference to more of somatic anatomy, cannot be ancestral. Phylogenetic filiation, as in the case of *Bahlia* which is more closely related to *Eutyphoeus,* is possible only through common descent from some form that is no longer extant (Gates, In press). *Scolioscolides,* at present known only from a single species originally placed in the Megascolecinae, is (Gates, 1937) still more closely related to *Eutyphoeus* by all of its anatomy than is either of the other genera. The ''living paleontology'' of the Indian Octochaetinae has vanished.

That portion of the gut in the nine to fifteen segments between gizzard and esophageal valve of Indian octochaetines has provided a striking demonstration of the importance of previously neglected organization. Using only characters from such a short region, a key was constructed (Gates, 1958b) that identifies genera (except *Scolioscolides*) and simultaneously indicates those likely to need drastic revision. The key is based on macroscopic anatomy. Microscopic structure of the calciferous glands undoubtedly will provide still other defining characters. In a short terminal portion of holonephridia, Pickford (1937) found macroscopically recognizable characters that could be used in defining Acanthodriline genera.

The classical *Megascolides* has marked discontinuities in its distribution: Peninsular India, the eastern Himalayas, Australia, Tasmania, and Oregon-Washington in North America. *M. bergtheili* Michaelsen 1907, of the Himalayas, is so nearly identical with the indubitably octochaetine and specialized *Eutyphoeus* that little more than the megascolecin terminalia is available to warrant even subgeneric separation. With that discovery (Gates, 1937), the single morphological distinction between the Octochaetinae and the Megascolecinae became taxonomically null and void. *M. prashadi* Stephenson 1920 and *annandalei* Stephenson 1921 are barely if at all distinguishable from the octochaetine *Eudichogaster barodensis* Stephenson 1914 which had to be separated off from the rest of the genus (Gates, 1939a) because of its somatic anatomy. *M. cochinensis* Michaelsen 1910, *M. duodecimalis* and *pilatus* Stephenson 1915, *M. chengannures* Aiyer 1929, have been transferred (Gates, 1940) also because of somatic anatomy to the octochaetine *Travoscolides*. *M. antrophyes* Stephenson 1924, known only from the holotype, unlike the other Indian species does seem to be megascolecine. Relationships, insofar as they could be determined in the circumstances, are with a local group of genera. With those discoveries *Megascolides* disappeared from the Orient.

The classical *Woodwardiella* of the Megascolecinae also has discontinuities in its distribution: India, Ceylon, Java, Australia. The Java record is due to transportation of a species from the west. Oriental species, because of somatic structure, had to be transferred to other genera including two, *Nellogaster* and *Nelloscolex*, that are not classical. Another genus, shared between Australia and South India, that is terminal like *Woodwardiella* in its own line of megascolecine evolution now (Gates, 1958b) has lost some of its morphological and phylogenetic heterogeneity in the same way. *Megascolex* is penultimate in its line of evolution but has, like its ancestor *Notoscolex*, endemic species only in South India-Ceylon and Australia, with or without New Zealand. A classical genus which is only one step removed from the parent of all octochaetines had endemic species only in New Zealand and peninsular India. To account for those distributions Michaelsen first postulated separate land bridges, from Australia and from New Zealand to India, and later invoked Wegenerian association of continental land masses. Independent origin of identical genera since the Cretaceous was Stephenson's explanation. *Octochaetus* was subsequently split into two subgenera, that were later raised to generic status, but the neoclassical *Octochaetoides* probably still requires (Gates, 1958b) subdivision. Resolution of the notorious and somatically indicated polyphyly of *Notoscolex* and *Megascolex* can be expected with confidence. In the Megascolecidae few genera will be retained, just as in the classical system; one such may be *Diplocardia;* another — the largest of all earthworm genera — is *Pheretima.* Yet, even in *Pheretima,* as already suggested, all genital organs except ovaries, oviducts and cocoon-secreting clitellum can be eliminated within a species, while other structure remains constant.

The wide oceanic discontinuities in distribution, that are so common in the Megascolecidae, characterize several genera of other earthworm families. The Moniligastridae has no such discontinuities, but genera as well as species are distinguished almost entirely by genital characters. Two genera of the little studied Glossoscolecidae provide some evidence (Gates, 1958a) of rapid evolutionary modification in genitalia. In the Lumbricidae, intermediate forms between most of the classical genera long have been known. A recent examination of a couple hundred specimens of an infrequently seen form (Gates, 1957a, p. 13) provided noteworthy instances of individual variation only with respect to those genital characters most used for defining and distinguishing species. In another lumbricid, all genital organs, except as in the above-mentioned pheretimas, have been eliminated, while other anatomical features remained constant. Most lumbricid genera appear (Gates, 1956a, p. 30) "to be only congeries of species associated because of relatively unimportant or superficial convergences." So little is known about so much of the taxonomically important structure in so many species, that *ex tempore* transfers from one polyphyletic genus to another (Gates, 1956a, p. 26) seem inadvisable. The somatic anatomy of various unmentioned subfamilies and families, as well as of the Glossoscolecidae, certainly is much less known than that of the Lumbricidae.

There is then little to indicate that other earthworms may have been classified, except perhaps by accident, more naturally than the megascolecids. The revision that is needed, throughout the megadrilous portion of the Oligochaeta, may have to be drastic.

Since 1900, one family and two subfamilies (see explanatory notes 7-9, following Table 2), several genera and many species have been erected. Of the latter, the number in *Pheretima* and *Dichogaster* already had been doubled (to *ca.* 300 and 160) by 1930. Many species still are known only from descriptions of a very short series, or of a single type, that sometimes has been aberrant. Little information about reproduction (whether sexual or parthenogenetic), individual and geographic variation has been recorded. Somatic anatomy, rather generally, is too inadequately characterized to permit grouping species according to over-all similarity. Until that information is available polyphyletic taxa cannot be made monophyletic with certainty by any reshufflings based on the literature.

Earthworms have been systematically collected in few areas, even in those immediately surrounding or easily accessible from museum and university centers. Such material as still may be available[5] in institutions usually is the casual spoil of other activities, almost always hastily preserved in the field, often more or less macerated, but if not, probably deteriorating slowly because methods of retaining specimens in good condition are unknown. Even the best of field-preserved material cannot be expected to provide all of the information that is needed, especially with regard to vascular and excretory systems. Decades must pass, so far as can be estimated from the rate of increase in knowledge during the last century, before data as to neglected portions of digestive and other somatic systems will be sufficient to permit grouping species and genera according to over-all similarity.

The problem to which we now return is that of finding a place for a new genus of unknown affinities in an obviously obsolescent

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[5] A list of extant types could not be provided by Michaelsen's own institution as late as 1958.

system, at a time when relationships of earthworms cannot be determined from the literature or from extant collections. In such circumstances changes in the system clearly should be minimal to avoid needless extensions in the future of already complicated synonymies.

Racemose prostates of the pheretima kind are present in genera that belong in a region extending through India, China, Malaysia and Australia, perhaps with some intrusion into New Zealand that is not due to human introductions. As wide oceanic intervals are lacking in that region it is possible that all of the forms under consideration have had a common origin. Accordingly, *Exxus* is assumed to be from the same Australasian region and to belong in the Megascolecinae, which alone contains genera having truly racemose prostates without a central canal. The subfamily, as pointed out long ago, already was undefinable morphologically. It can be defined, by its prostates, if forms with tubular glands, regardless of presence or absence of lateral branches from the axial lumen, are excluded. Mesodermal origin of the prostate, in a group where diagnostic characters are few, appears to be an evolutionary innovation of sufficient importance to justify more than subfamily status. The Megascolecinae of Stephenson (1930), as now restricted, accordingly becomes a family in partial agreement with Michaelsen's (1921, 1929) later proposals.

Genera now excluded from the Megascolecidae are distributed among the other subfamilies, in accordance with precedents set when Stephenson, Michaelsen and Pickford disbanded the Trigastrinae and the Diplocardiinae. Thus, genera with holonephric excretory systems throughout go into the Acanthodrilinae, and meronephric genera go into the Octochaetinae. Each of those two groups of genera seems to be entitled to the same rank as the Ocnerodrilidae, which was separated off some years ago (Gates, 1939b). Such rearrangements, in the neoclassical manner, satisfy Stephenson's criterion of convenience. They permit reference to or discussion of groups, having a limited degree of common morphology, independently of the highly subjective phylogenetic esotery on which the classical system is really based.

The synopsis below summarizes the proposed changes along with brief definitions and generic lists.

- A_1. Prostates racemose, of pheretima type, without central canal and presumably of mesodermal origin. MEGASCOLECIDAE. Comprises the following genera, some of them perhaps in part only, *Lampito, Pheretima, Perionyx, Plionogaster, Woodwardiella, Comarodrilus, Notoscolex, Megascolex, Digaster, Perissogaster, Didymogaster, Nellogaster, Tonoscolex, Nelloscolex* and *Exxus.*
- A_2. Prostates tubular, with central canal, of ectodermal origin.
  - B_1. Pre-intestinal region short with latero-esophageal hearts confined to x-xi and intestinal origin in or (usually) anterior to xiv. (Setal arrangement lumbricin. Calciferous glands or epithelial-lined diverticular spaces in thickened esophageal wall, in ix-x. Excretory system holonephric.) OCNERODRILIDAE. Genera as in Stephenson, 1930, except for *Aphanascus* which was united with *Malabaria* (Gates, 1942), *Kerria* and *Curgia* which are now known as *Eukerria* and *Curgiona,* and in addition *Deccania.*
  - B_2. Pre-intestinal region longer, with intestinal origin in or behind xv and with hearts not confined to x-xi or their homoeotic equivalents.
    - C_1. Excretory system holonephric. ACANTHODRILIDAE. Genera as in Stephenson, 1930, with addition of *Eodrilus, Parachilota, Diplocardia, Zapotecia* and from the megascolecinae *Diplotrema, Plutellus, Pontodrilus, Diporochaeta.*
    - C_2. Excretory system meronephric. OCTOCHAETIDAE. Genera as in Stephenson, 1930, with addition from the Megascolecinae of *Spenceriella, Megascolides,* as well as the neoclassical *Wegeneriona, Neogaster,* also *Scolioscolides, Lennogaster, Barogaster, Rillogaster, Priodochaeta, Priodoscolex, Travoscolides,* and *Celeriella.*

The tubular prostates do seem to suggest a closer affinity to each other, than to the Megascolecidae, of the families Ocnerodrilidae, Acanthodrilidae and Octochaetidae, which were all included in his Acanthodrilidae by Michaelsen (1921, 1929). Any attempt at formal taxonomic indication of the relationship, in the present circumstances, scarcely seems worth while. Interposition of suborder and series between order and families, as in Michaelsen's later schemes, still seems, in agreement with Stephenson (1930, p. 719), to be unwarranted by our present knowledge.

TABLE 2. Earthworm families and subfamilies in recent classifications of the Oligochaeta

Michaelsen 1900	Michaelsen 1921	Stephenson 1923	Stephenson 1930	Pickford	Herein Proposed
	Neo-oligochaeta (1)				
Megascolecidae	Megascolecina	Megascolecidae			
Eudrilinae	Eudrilidae	Eudrilinae	Eudrilidae		Eudrilidae
			Megascolecidae	Megascolecidae (2)	Megascolecidae
Megascolecinae	Megascolecidae	Megascolecinae	Megascolecinae	Megascolecinae	
	Acanthodrilidae				
Acanthodrilinae	Acanthodrilinae	Acanthodrilinae	Acanthodrilinae	Acanthodrilinae	Acanthodrilidae
Trigastrinae	Trigastrinae (6)				
Diplocardiinae	Diplocardiinae	Diplocardiinae	Diplocardiinae (6)		
Octochaetinae	Octochaetinae	Octochaetinae	Octochaetinae	Octochaetinae	Octochaetidae
Ocnerodrilinae	Ocnerodrilinae	Ocnerodrilinae	Ocnerodrilinae	Ocnerodrilinae	Ocnerodrilidae (3)
	Lumbricina	Lumbricidae			
Lumbricidae	Lumbricidae	Lumbricinae	Lumbricidae		Lumbricidae (7)
Glossoscolecidae			Glossoscolecidae		
Glossoscolecinae	Glossoscolecidae	Glossoscolecinae	Glossoscolecinae		Glossoscolecidae
Hormogastrinae	Hormogastridae	Hormogastrinae	Hormogastrinae		Hormogastridae
Microchaetinae	Microchaetidae	Microchaetinae	Microchaetinae		Microchaetidae
Criodrilinae	Criodrilidae	Criodrilinae	Criodrilinae		Criodrilidae
	Sparganophilidae	Sparganophilinae	Sparganophilinae		Sparganophilidae
	Phreoryctina				
		Moniligastridae	Moniligastridae		
Moniligastridae	Moniligastridae	Moniligastrinae	Moniligastrinae		Moniligastridae (4)
	Syngenodrilidae	Syngenodrilinae	Syngenodrilinae	Syngenodrilidae (5)	
Alluroididae	Alluroididae	Alluroididae	Alluroididae	Alluroididae	Alluroididae (5)
Haplotaxidae	Phreoryctidae	Haplotaxidae	Haplotaxidae	Haplotaxidae	Haplotaxidae

(1)-(9) refer to explanatory notes.

EXPLANATORY NOTES

(1) Suborders of the 1921 scheme, the Archioligochaeta and Neo-oligochaeta, were abandoned in 1929. The suborders then proposed are three, Oligochaeta plesiopora, prosopora and opisthopora.

(2) Pickford, 1937.

(3) Gates, 1939, 1942.

(4) Gates, 1945. In this article, an editor made the author say (p. 394) ''Hearts of vi and vii connect the dorsal and ventral trunks to a longitudinal vessel that appears to be an extra-esophageal,'' which is incorrect and unfortunately was repeated (Pickford, 1945) in a formal redefinition of the Syngenodrilidae. The ''hearts,'' so far as could be determined from the available material, connect the dorsal and ventral trunks only. Another editorial change was deletion of a statement to the effect that the ''hearts'' are median to the extra-esophageals. Those trunks, so far as is known and except in *Syngenodrilus* and the Moniligastridae, are median to hearts and segmental loops. The pair of characters, lateral to or median to the hearts and segmental loops, eventually will prove to be of considerable taxonomic importance.

(5) Pickford, 1945. Also *cf*. Gates, 1945. Recognition of a family, or even a subfamily, for *Syngenodrilus* alone, at present scarcely seems warranted from, quoting Stephenson, the point of view of convenience or by our knowledge of relationships.

(6) The Trigastrinae of 1900 and 1921 disappeared when Stephenson transferred the Indian *Eudichogaster* (which had been split off from the Afro-American *Dichogaster*) to the Octochaetinae, *Trigaster, Eutrigaster, Dichogaster* and *Monogaster* to the Diplocardiinae. Michaelsen (1933) suggested transfer from the Diplocardiinae to the Octochaetinae of the meronephric *Trigaster, Dichogaster* (presumably including *Eutrigaster*) and *Monogaster*. Genera still left in the Diplocardiinae, the holonephric *Diplocardia* and *Zapotecia,* were placed by Pickford (1937) in the Acanthodrilinae.

(7) The Criodrilinae of 1900 became monogeneric by erection of a family for *Sparganophilus,* transfer to the Microchaetinae of the African *Alma* as well as the American *Drilocrius* (split off from *Criodrilus*).

Pop (1949) included *Criodrilus* in the Lumbricidae without subfamily divisions. Omodeo (1956) excluded *Criodrilus* and recognizes two subfamilies, Lumbricinae and Eiseninae.

(8) The monospecific Hippoperidae was erected (Taylor, 1949) for a eudrilid supposedly distinguished from the rest of the family by presence of a second pair of male pores.

(9) Megascolecid subfamilies are reduced to two in a publication (Lee, 1959) received after the manuscript of this contribution had been typed.

Acanthodrilinae. "One pair of prostatic pores on xvi (rarely) or xvii or xix, or two pairs on xvii and xix (rarely the two pairs may be further back); one pair of male pores, usually on xviii, sometimes on neighbouring segments, sometimes combined with a pair of prostatic pores (in which case, never on xviii); prostates with unbranched central canal." Comprising *Acanthodrilus, Microscolex, Rhododrilus, Dinodriloides, Perieodrilus, Maoridrilus, Neodrilus, Plagiochaeta, Chilota, Yagansia, Udeina, Eodrilus,* the diplocardiine *Diplocardia, Zapotecia, Trigaster, Eutrigaster, Dichogaster, Monogaster,* the octochaetine *Howascolex, Octochaetus* (including *Octochaetoides*), *Dinodrilus, Hoplochaetina, Ramiella, Eudichogaster, EUTYPHOEUS, Hoplochaetella,* the neoclassical *Leucodrilus, Decachaetus, Eudinodriloides, Sylvodrilus* and *Neochaeta,* the Ocnerodriline *Maheina, Curgiona, Malabaria, Paulistus, Eukerria, Kerriona, Haplodrilus, Ocnerodrilus, Pygmasodrilus, Nematogenia,* as well as *Nelloscolex, Tonoscolex, Rillogaster* and *Lennogaster.*

Megascolecinae. "One pair of prostatic pores and one pair of male pores on xviii (*Diplotrema* only) or one pair of combined male and prostatic pores on xviii; prostates with unbranched or branched central canal." Comprising *Diplotrema, Plutellus, Pontodrilus, Woodwardiella, Comarodrilus, Megascolides, Spenceriella, Notoscolex, Megascolex, Pheretima, Plionogaster, Digaster, Perissogaster, Didymogaster, Diporochaeta, Perionyx,* the ocnerodriline *Quechua* (should be *Quechuona*), as well as *Barogaster, Priodochaeta, Priodoscolex, Travoscolides* and *SCOLIOSCOLIDES.* The ocnerodriline *Gordiodrilus* and several neoclassical genera were not placed.

These changes, like others in the neoclassical manner, are not based on any substantial increase in knowledge of somatic anatomy. Similarity, for each subfamily, is restricted to presence or absence of united male and prostatic pores in xviii only (megascolecin terminalia). Elucidation of the relationship between *Eutyphoeus* and *Scolioscolides* showed conclusively that the two subfamilies cannot be so distinguished. Further proof probably will be provided by the ocnerodriline genus (*Gordiodrilus*) that could not be placed in either of the revised units. Branching of a central prostatic canal was recorded in some species of *Diplocardia* more than sixty years ago. A central canal is lacking in the prostates of *Nelloscolex* and *Tonoscolex*. *Quechuona* has a short pre-intestinal region (with hearts in x-xi only) such as is characteristic of nearly all ocnerodriles. The megascolecin male terminalia probably are present in *Gordiodrilus*, which clearly belongs in the same family with *Quechuona* and other ocnerodriles.

SUMMARY

In the "classical" system of the Oligochaeta, species are museum taxa, i. e., based on resemblance in a few macroscopically recognizable characters to a type specimen that sometimes was quite abnormal. Information as to individual and geographical variation usually is lacking. Genera, defined by a very few "key" characters and often obviously polyphyletic, are arranged in larger units according to a phylogenetic esotery. Definitions of subfamilies and families are statements of range of variation in certain characters most of which are used to define genera. The system is artificial and obsolescent. Revision of genera on a basis of over-all similarity of species is impossible because of absence in the literature of information about much somatic anatomy. Material needed for adequate characterization of the species (many without types) is unavailable in institutions and is unlikely to be secured for many years to come. To accommodate *Exxus wyensis*, the Megascolecidae of the latest monograph on the Oligochaeta is redefined to include only genera having racemose prostates of the pheretima sort. Excluded species with holonephric and meronephric excretory systems respectively are transferred to the Acanthodrilidae and Octochaetidae.

REFERENCES

BAHL, K. N.

1919. On a new type of nephridia found in Indian earthworms of the genus *Pheretima*. Quart. Jour. Micros. Sci., **64:** 67-119.

1922. On the development of the "enteronephric" type of nephridial system found in Indian earthworms of the genus *Pheretima*. *Ibid.*, **66:** 49-103.

1924. On the occurrence of the "enteronephric" type of nephridial system in earthworms of the genus *Lampito*. *Ibid.*, **68:** 67-99.

1926. The enteronephric system in *Woodwardia* with remarks on the nephridia of *Lampito dubius*. *Ibid.*, **70:** 113-134.

1941. The enteronephric type of nephridial system in the genus *Tonoscolex* (Gates). *Ibid.*, **82:** 443-466.

1942. Studies on the structure, development and physiology of the nephridia of Oligochaeta. Part I. General introduction, and the nephridia of the subfamily Octochaetinae. Part II. Multiple funnels of the nephridia. *Ibid.*, **83:** 423-457. III. The branching and division of nephridia and Eisen's so-called "safety valves" in *Pontoscolex*. IV. The enteronephric system in *Megascolex cochinensis*, with remarks on vestigial nephridia. *Ibid.*, **84:** 1-34.

1945. Part V. The enteronephric system in *Megascolex ceylonicus* and *M. sarasinorum*, with remarks on the phagocytic organs in *Megascolex templetonianus*. *Ibid.*, **85:** 177-190.

1946. Part VIII. The enteronephric type of nephridial system in earthworms belonging to three species of *Megascolex* Templeton and three species of *Travoscolides* Gates (Megascolides McCoy). *Ibid.*, **87:** 45-60

GATES, G. E.

1937. Indian earthworms. II. *Scolioscolides*. Rec. Indian Mus., **39:** 305-310.

1938. Indian earthworms. III. The genus *Eutyphoeus*. *Ibid.*, **40:** 39-119. IV. The genus *Lampito* Kinberg. V. *Nellogaster*, gen. nov., with a note on Indian species of *Woodwardiella*. *Ibid.*, **40:** 403-429.

1939a. Indian earthworms. VI. *Nelloscolex*, gen. nov. *Ibid.*, **41:** 37-44. VII. Contribution to a revision of the genus *Eudichogaster*. *Ibid.*, **41:** 151-218.

1939b. Thai earthworms. Jour. Thailand Res. Soc. Nat. Hist. Suppl., **12:** 65-114.

1940. Indian earthworms. VIII. *Priodochaeta*, gen. nov. IX. *Priodoscolex*, gen. nov. X. Contribution to a revision of the Indian section of the genus *Megascolides*. XI. *Travoscolides*, gen. nov. Rec. Indian Mus., **42:** 115-143.

1942. Notes on various peregrine earthworms. Bull. Mus. Comp. Zool. Harvard College, **89:** 63-144.

1943. On some American and Oriental earthworms. Ohio Jour. Sci., **43:** 87-116.

1945. On the Oligochaete genus *Syngenodrilus* and its taxonomic relationships. Jour. Washington Acad. Sci., **35:** 393-396.

1956a. Notes on American earthworms of the family Lumbricidae. III-IV. Bull. Mus. Comp. Zool. Harvard College, **115:** 1-46.

1956b. Reproductive organ polymorphism in earthworms of the oriental megascolecine genus *Pheretima* Kinberg 1867. Evolution, **10:** 213-227.

1957a. Contributions to a revision of the earthworm family Lumbricidae. I. *Allolobophora limicola.* Breviora, Mus. Comp. Zool., **81:** 1-14.

1957b. Contribution to a revision of the earthworm family Ocnerodrilidae. The genus *Nematogenia.* Bull. Mus. Comp. Zool. Harvard College, **117:** 427-445

1958a. On a hologynous species of the earthworm genus *Diplocardia,* with comments on oligochaete hologyny and "consecutive hermaphroditism." Amer. Mus. Nat. Hist. Novitates, no. 1886; 1-9.

1958b. On Burmese earthworms of the megascolecid subfamily Octochaetinae. Ann. Mag. Nat. Hist., (13) **1:** 609-624.

195?. On a species of the Indian earthworm genus *Eudichogaster.* (In Press.)

In press. The earthworms of Burma. VII. The genus *Eutyphoeus,* with notes on several Indian species. Rec. Indian Mus., **53:** 93-222. (MS submitted in 1954. Page proof bearing publication date of 1955 corrected in 1956.)

LEE, K. E.

1959. The earthworm fauna of New Zealand. New Zealand Dept. Sci. Indust. Res. Bull., **130:** 1-486.

MICHAELSEN, W.

1900. Oligochaeta. Das Tierreich, vol. 10, i-xxix, 1-575.

1921. Zur Stammesgeschichte und Systematik der Oligochäten, insbesondere der Lumbriculiden. Arch. Naturgesch., (A) **86** (8): 130-141.

1929. Zur Stammesgeschichte der Oligochäten. Zeitschr. Wiss. Zool., **134:** 693-716.

1933. Die Oligochätenfauna Surinames. Mit Erörterung der verwandschaftlichen und geographischen Beziehungen der Octochätinen. Tijdschr. Nederlandsch Dierk. Ver., (3) 3: 112-131.

OMODEO, P.

1956. Contributo alla revisione dei Lumbricidae. Arch. Zool. Italiano, **41:** 129-212.

1958. La reserve naturelle integrale du Mont Nimba. I. Oligochetes. Mem. Inst. Afrique Noire, **53:** 9-109.

PICKFORD, G. E.

1937. A monograph of the Acanthodriline earthworms of South Africa. Cambridge, 1-612.

1945. Additional observations on the oligochaete genus *Syngenodrilus*. Jour. Washington Acad. Sci., **35:** 397-399.

POP, V.

1950. Lumbricidele din Romania. An. Acad. Romane, Sect. Sti. Geol. Geogr. Biol., (A) 1 (9): 1-129.

SAVIGNY, J. C.

1826. *In:* Cuvier, G. Analyse des travaux de l'Academie royale des Sciences, pendant l'annee 1821. Partie physique. Mem. Acad. Roy. Sci. Inst. France, **5:** 153-203.

SMITH, F.

1924. The calciferous glands of Lumbricidae and *Diplocardia*. Illinois Biol. Mon., **9:** 1-76.

STEPHENSON, J.

1921. Contributions to the morphology, classification and zoogeography of the Indian Oligochaeta. Proc. Zool. Soc. London, 1921: 103-142.

1923. Oligochaeta. *In:* Fauna of British India including Ceylon and Burma, London, xxiv +518 pp.

1930. The Oligochaeta. Oxford, xiii +978 pp.

STEPHENSON, J. and H. RAM

1919. The prostate glands of the earthworms of the family Megascolecidae. Trans. Roy. Soc. Edinburgh, **52:** 435-453.

TAYLOR, A. G.

1949. A West African earthworm, *Hippopera nigeriae*, belonging to a new family Hippoperidae. Proc. Zool. Soc. London, **119:** 703-710.

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BATHONIAN FORAMINIFERA OF ENGLAND

By Richard Cifelli

With Seven Plates

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No. 7 — *Bathonian Foraminifera of England*

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INTRODUCTION

Whereas the Jurassic megafauna of England has been intensively studied for over a century, the Foraminifera and other miroscopic fossils have, until recently, received but scant attention. Before Macfadyen (1941) published his excellent account of the Foraminifera from the Green Ammonite Beds in the Lower Lias of the Dorset Coast there were perhaps two dozen papers in the literature dealing with the Jurassic Foraminifera of England. All of these were published before the turn of the century, and most of them contain but few descriptions or illustrations. In almost all instances they are concerned with the faunas of the Lias. Since World War II there has been a renewed interest in Foraminifera, largely through the efforts of

Barnard and his students. A number of important papers have appeared (Barnard, 1950a, 1952, 1953, 1956, 1957; Adams, 1957), but again, almost all of them thus far have dealt only with the Lias. No Foraminifera have ever been described from the English Bathonian and the only previous records of Foraminifera in this stage are a few lists of species and genera in the older literature. These are of little value because of the uncertainties in identification and nomenclature.

In this paper 104 species, subspecies and varieties (exclusive of attached forms) are described and their known stratigraphic occurrences are recorded. These include one species (*Massilina dorsetensis*) and one subspecies (*Vaginulina clathrata eypensa*) which are new. There are, in addition, several previously undescribed varieties, but these are not given formal taxonomic status here.

No claim is made that this represents the entirety of the Bathonian foraminiferal fauna. The strata of the Bathonian are generally poorly exposed in England, and parts of them are completely concealed. As new road cuts and quarries make additional exposures available there will undoubtedly be descriptions of new and previously unrecorded species as well as additional records of stratigraphical occurrences of known forms. There are four foraminiferal faunules that can be distinguished, which should provide a framework for future faunal divisions of this stage. The faunules are provisional units and can not be used to establish zones at present, because their stratal limits are not known, and their relationships to larger Middle Jurassic faunal units within the European province are not yet known. However, the faunules can be recognized in Dorset and the Bath areas, where they occur in the same order of superposition. Consequently, they probably contain stratigraphically restricted species which should later prove useful in establishing zones based on Foraminifera.

The Bathonian fauna, like other Jurassic faunas, is characterized by the dominance of the Lagenidae. Representatives of this family occur in a large variety of sediments, and in practically all instances they are the most common forms in the foraminiferal assemblages. Other families are represented by few, unspecialized, genera and species.

It is well known that many species of Jurassic Lagenidae are highly variable. Only recently, however, have there been any attempts to describe the variation of species (Barnard, 1950a, b; Adams, 1957). Classification of specimens is difficult because species and genera do not have well defined morphological limits. Nevertheless, it is believed that recognition of variation is vital to an understanding of the evolution of the family; consequently many lagenid species are conceived here quite broadly.

Methods

Field work for this investigation was conducted during the summer of 1955. All of the samples are from surface outcrops and each of them weighed about 2 pounds before washing. The samples were prepared in the conventional manner of disaggregating in water, sometimes with the assistance of boiling, or adding hydrogen peroxide, and passing them through a 200-mesh screen. In some instances the sample was entirely picked clean, but most of the residues were so large that they were first quartered with a micro-splitter. In the records of species the following scale of relative abundance was used.

In each sample,

rare	corresponds to	1- 3	specimens
few	" "	4- 7	"
common	" "	8-19	"
abundant	" "	over 20	specimens

During the spring of 1956 I examined a number of collections containing species previously described from the Jurassic of Europe. Wherever specimens from these collections were used in the identifications of species they are noted in the discussion following the synonymies and descriptions of the species. The types and figured specimens are deposited at the Museum of Comparative Zoology, Harvard University.

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Finally, I am indebted to Dr. T. Barnard for assistance and the facilities provided at University College during my stay in London.

STRATIGRAPHY

The Bathonian Stage in England

The English strata included in the Bathonian Stage are shown in Figure 1, following Arkell's (1951, pp. 16-22) interpretation of d'Orbigny's definition of this stage.

In general, the Bathonian in England corresponds to the Great Oolite Series, a lithogenetic unit composed of a highly variable sequence of rocks, chiefly limestones, clays and marls between the Inferior Oolite below and the Oxford Clay and Kellaway Beds above. To Americans unaccustomed to British stratigraphic nomenclature, the term Series is apt to be confusing, as in America that term has been standardized in a time-rock sense, denoting a unit larger than a Stage, but smaller than a System. In Great Britain, however, the term is lithogenetic, and is used to unite distinct, but related, rock units without any time connotations. It is similar to the term Group, except that whereas Group combines two or more rock units of formational rank, Series combines rock units of all magnitudes, regardless of rank.

In general, the major units of the Great Oolite Series (often, but not always designated as formations) are as follows, in ascending order: Fuller's Earth Clay, Great Oolite Limestones,

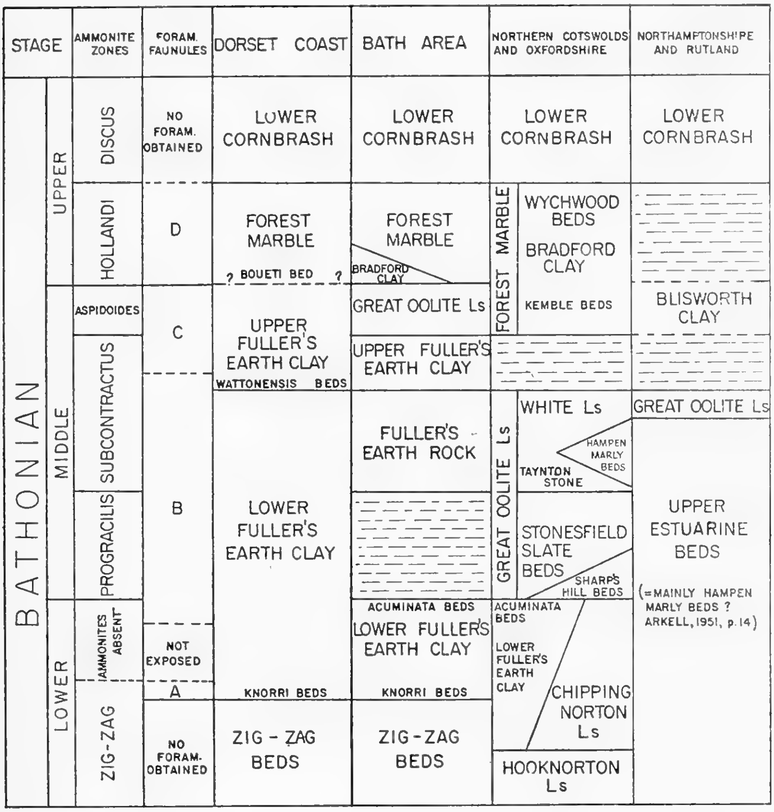

Figure 1. Inferred relationships of English Bathonian strata.

Forest Marble and Cornbrash. All of these strata are Bathonian except the Upper Cornbrash, which is Callovian. In addition, the base of the Bathonian includes the *Zigzag* Beds, which comprise the upper few feet of the Inferior Oolite. No Foraminifera were collected from the *Zigzag* Beds or the Cornbrash.

The Great Oolite Series is highly variable and is characterized by great facies changes, particularly below the Forest Marble. In southern England, along the Dorset Coast, the Forest Marble directly overlies the Fuller's Earth Clay. In the Bath District the Great Oolite Limestone intervenes between the two formations, and farther north in the Cotswolds and Oxfordshire the Fuller's Earth Clay is mostly replaced by the Great Oolite Limestones. These pass northward into the Yorkshire basin, where the Bathonian consists mostly of sands and clays of nonmarine, deltaic origin. The maximum thickness of the Bathonian is in south Somerset, where it reaches a thickness of 500 feet (Arkell, 1951, p. 7). In Northamptonshire the thickness is only about 100 feet.

Ammonites, which are generally common throughout the English Jurassic and provide accurate guides for subdivisions of this system, are scarce and unevenly distributed in the Bathonian. They are common only in the *Zigzag* Beds and in the Cornbrash. In the Fuller's Earth Clays and much of the Great Oolite Limestones they are very rare or absent. It is only recently that the Bathonian has been divided into zones based on ammonites (Arkell, 1951, p. 21). It is doubtful, however, that these zones are as reliably established as others in the Jurassic. At Whatley in Somerset, for example, a recent large collection of ammonites from the *Rugitella* Beds, a few feet above typical *Subcontractus* Zone, yielded a mixture of Lower, Middle and Upper Bathonian species. Arkell (1957, p. 324) states, "The assemblage from the *Rugitella* Beds at Whatley is highly anomalous. It does not contain any of the zonal index species or genera of the Lower, Middle or Upper Bathonian (*Zigzagiceras, Morphoceras, Tulites, Morrisiceras, Clydoniceras*) but consists of a mixture of accessory ammonites individually considered characteristic of all 3 subdivisions of the Bathonian, but never previously found together." It appears that even these most honored of all index fossils may sometimes be susceptible to facies changes, as are other fossils.

Because of this lack of ammonites, correlations within the Bathonian are difficult, and the relationships of many of the strata are uncertain. Brachiopods are locally abundant, but their distribution is uneven, and they have been useful, thus far, only for local correlations. Foraminifera are abundant throughout most of the Bathonian, but this present effort represents but a beginning in the establishment of the Bathonian foraminiferal succession.

The stratigraphy of the English Bathonian has already been summarized (Woodward, 1894; Arkell, 1933, 1951, 1956; Arkell and Donovan, 1952), and the present account is limited to those details necessary to understanding the succession of Foraminifera. The major relationships of the strata are summarized in Figure 1, which has been compiled from many sources in the literature, but conforms mostly to the authority of Arkell.

Dorset Coast

The best English Bathonian exposures are found along the Dorset Coast between Bridport and Weymouth. A composite section showing the stratigraphic positions of the foraminiferal samples is given in Figure 2 and the stratigraphic occurrences of the foraminiferal species are shown in Table 1. The strata are nowhere exposed in their entirety and the section has been pieced together from a number of localities (Arkell, 1933, p. 250).

The Lower Fuller's Earth Clay is poorly exposed and most of it is never seen. Some of the clay occurs in the eastern part of Watton Cliff, but the beds there are faulted and the stratal relations are uncertain. The lower few feet of the Lower Fuller's Earth Clay are exposed at the top of Burton Cliff, between the Bredy River and Burton Bradstock. The cliff is not readily accessible and the present samples were obtained from a large boulder at the bottom of the cliff which had toppled from the top. The block contained 6 feet of Lower Fuller's Earth Clay, including a few inches of Scroff at its base, underlain by the *Zigzag* Bed and the Inferior Oolite.

The Fuller's Earth Rock does not extend into the Dorset Coast and overlying the Lower Fuller's Earth Clay in this area are the *Wattonensis* Beds (Kellaway and Wilson, 1941, p. 160),

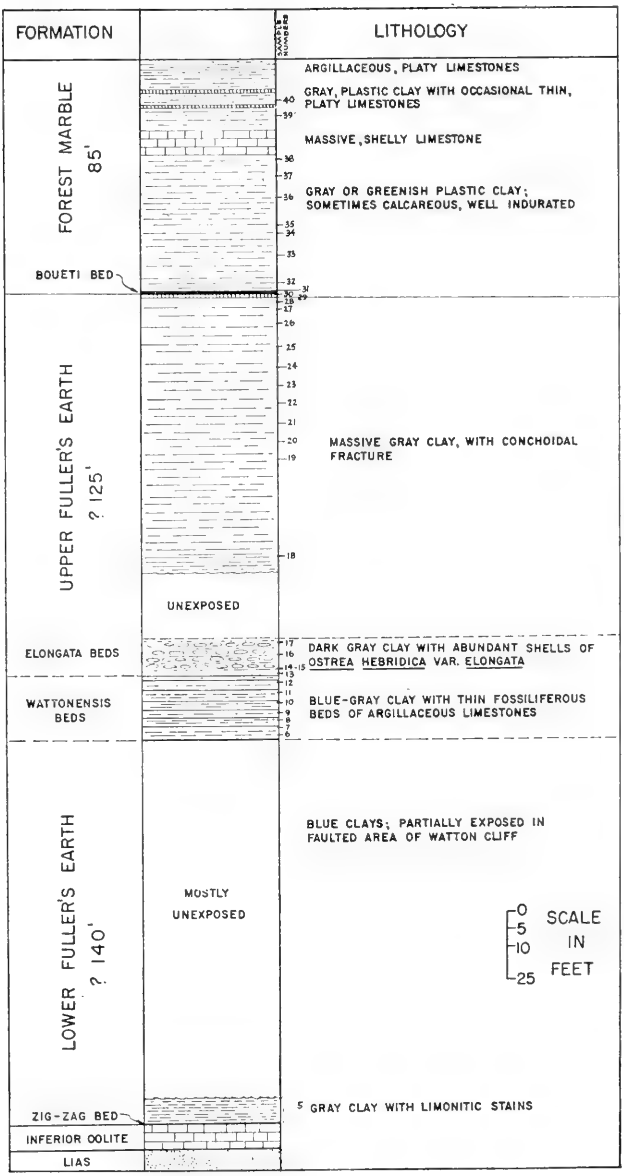

Figure 2. Composite section of Bathonian strata of the Dorset Coast.

a series of dark, argillaceous limestone bands with intervening clays. They occur along the beach at the base of Watton Cliff, just east of Eype Mouth. The beds strike NNE, parallel to the fault which extends through Eype Mouth, and dip sharply to the east. There are about eight limestone bands, each about one-half to one foot thick and as many intervening clays. The total thickness is estimated to be twenty-five feet (Buckman, 1922, p. 381), but the outcrop is mostly covered by the shingle and can be observed at the foreshore only at unusually low tides. Foraminifera were collected from the clay bands, immediately below each limestone.

At Watton Cliff there are approximately 100 feet of the Upper Fuller's Earth Clay exposed in the vertical cliff wall. The upper contact is clearly defined in the brow of the cliff, where the Upper Fuller's Earth Clay is overlain by the Forest Marble, with the *Boueti* Bed at the base. A much more accessible section is exposed 3 miles to the east at Cliff's End, Burton Bradstock, where there are about 60 feet exposed and overlain by the *Boueti* Bed (Arkell, 1933, p. 253). The clay is arenaceous and contains abundant fragments of quartz, chert and mica. The lower portion of the Upper Fuller's Earth Clay is concealed beneath the beach and is not visible in the vicinity of Bridport, but the lower beds are exposed 12 miles to the east, at Langton Herring. They consist of tough, dark gray clays containing masses of shells belonging mostly to *Ostrea hebridica* var. *elongata* Dutertre. This is the *Elongata* Bed, which is 12 feet thick at Langton Herring and is underlain by the *Wattonensis* Beds (Arkell, 1933, p. 252).

The base of the Forest Marble is represented by the *Boueti* Bed, a remarkably persistent fossiliferous marl, only one foot thick and characterized chiefly by the abundance of *Goniorhynchia boueti* (Davidson). This bed is best seen at Herbury along the West Fleet, but persists as far inland as Wincanton and Sherborne (Kellaway and Wilson, 1941, p. 162). In the past it has been customary to correlate the *Boueti* Bed with the Bradford Clay, as is shown in the chart in Figure 1. Recently, however, Sylvester-Bradley (1957, p. 27) has presented evidence to suggest that the *Boueti* Bed is older than the Bradford Clay and is the equivalent of the Bath Freestone in the Bath area.

The older, conventional correlation is retained here, however, pending a more complete statement on the problem.

Practically the entire Forest Marble is exposed at Watton Cliff, and is accessible at Fault Corner. The following section was obtained (measured by Cifelli and McNichol, 1955):

	feet
Platy, argillaceous limestone, gray on fresh surface, weathering rust brown; interbedded with thin marl bands; grades into clays below.	7
Gray or green soft, plastic clay, sandy, micaceous, with thin bands of argillaceous limestone becoming more numerous towards top.	21
Massive, oolitic limestone, gray on fresh surface, weathering buff, crossbedded; abundant broken shells, pectenids, oysters and few brachiopods.	10
Gray or green or brown soft clays, weathering to rust brown; sandy, micaceous; interbedded with thin, calcareous, well indurated clays containing shell fragments.	47
Total	85

Localities of foraminiferal samples:

Samples 1-5 were all collected from a single boulder at the base of Burton Cliff, 1.2 miles southeast of Bridport Harbour. The total stratigraphic interval represented in the boulder is about 6 feet.

Samples 6-13 were collected from the foreshore of Watton Cliff, at low tide level. Each sample was taken from the clay immediately underlying each of the argillaceous bands. The most westerly and stratigraphically lowest of these was located about 30 yards east of Eype Mouth.

Samples 14-15 were collected along the West Fleet, about 600 yards west of the Coast Guard Station at Langton Herring. Samples 16-17 are from the *Elongata* Beds, about 200 yards west of the ferry at Langton Herring.

Sample 18 was taken from the vertical cliff wall of Watton Cliff, about midway between Eype Mouth and West Bay, about 10 feet above the level of the beach.

Samples 19-27 are from Cliff's End, in the cove about 300 yards WNW of the Coast Guard Station.

Samples 28-31 were collected from Herbury, about 1 mile south of Langton Herring.

Samples 32-40 were collected from the western part of Watton Cliff, at Fault Corner, near Eype Mouth.

Bath Area

Stratigraphic investigations in the Bath area date back to the mapping of William Smith. Exposures at the present time are poor, however, and most of the quarries and railroad cuttings from which the succession was established are now covered. Only isolated portions of the sequence are revealed and the exact horizons of some of the exposures are uncertain. For this reason, Foraminifera collected from the Bath area have not been compiled into a single, composite check list. They are shown in individual tables for each formation, at the localities from which they were collected (Tables 2-11).

The most complete section of the Lower Fuller's Earth Clay in the Bath area was obtained by Richardson (1910, p. 426) from a railway cutting at Combe Hay, about 3 miles south of Bath. Richardson recorded 35 feet of the clay, containing *Zigzagiceras* at the base, resting on the Inferior Oolite. There was no trace of the Fuller's Earth Rock, but the occurrence of *Ostrea acuminata* in the upper layers suggested that almost the entire thickness of Lower Fuller's Earth Clay was represented (Arkell, 1933, p. 280). The cutting is now obscured, but 2 miles east of Combe Hay in the railway embankment at Midford there are 10-12 feet of the clay resting on the Inferior Oolite. The weathered, yellow clay which can be reached within a couple of feet of the grass covered surface yields numerous, moderately well preserved Foraminifera.

The Fuller's Earth Rock is well developed in the Bath area. It is still exposed in the road cut between Maperton and Charleton-Horetorne, where it rests on the Lower Fuller's Earth Clay. The section was described by Richardson (1909, p. 213) who recorded 22½ feet of Fuller's Earth Rock and 15 feet of Lower Fuller's Earth Clay. In the town of Box, 5 miles northeast of Bath, the upper part of the Lower Fuller's Earth Clay appears to be overlain by the Fuller's Earth Rock. The area has not been mapped in detail and the stratal relations are not certain. However, in the summer of 1955 a drainage ditch was dug at the road intersection about 50 yards down hill from Rose Cottage in Box. It revealed a rubbly, oolitic limestone underlain by 6 feet of dark brown clay. Another ditch, about 10 feet below the first, exposed an additional few feet of clay. In view of the Old Series 1 inch map showing the Great Oolite Series at Box and Lycett's record of 148 feet of Fuller's Earth, including Fuller's Earth Rock at Box Tunnel (Arkell, 1933, p. 281), it appears likely that the upper part of the Lower Fuller's Earth Clay and the Fuller's Earth Rock were represented in the ditches. Foraminifera were collected from the clays (Table 4).

At Cross Ways Inn, a few miles south of Bath, at the intersection of the roads to Radstock and Timsbury, Cox (1941, p. 20) described the following section:

	feet
Marly clay (Upper Fuller's Earth)	2—0
Rubbly limestone (Fuller's Earth Rock proper), with pelecypods and brachiopods including species of *Rugitella, Ornithella, Rhynchonelloidea, Wattonithyris*	5—0
Mottled clay	5—0
Limestone	0—6
Clay with *Rhynchonelloidea turcheri*	1—6
Argillaceous limestone	0—6
Mottled clay	5—0
Clay with abundant *Ostrea acuminata*	1—0
Clay	3—0
Estimated thickness of beds underlying grass slope to top of Inferior Oolite	15—0

The section is unusual in that there are only 5 feet of rubbly limestone ("Fuller's Earth Rock proper") represented and 12½ feet of clay intervene between the limestone and the clay containing *Ostrea acuminata.* Normally the *Acuminata* Beds occur immediately below the Fuller's Earth Rock and traditionally they have been regarded as a constant paleontological horizon marking the top of the Lower Fuller's Earth Clay. However, this oyster was found to straddle the boundary and occur in the Fuller's Earth Rock at Whatley (Sylvester-Bradley and Hodson, 1957, p. 315). The section at Cross Ways Inn is now covered with grass, but one sample was recovered about 4 feet below the surface which yielded a rich assemblage of Foraminifera (Table 6).

North of Bath the Fuller's Earth Rock splits into 2 separate limestone bands, an upper Tresham Rock and a lower Cross Hands Rock, separated by a clay bed (Hawkesbury Clay). No Foraminifera were obtained from these units.

The best known part of the Upper Fuller's Earth Clay is the commercial clay which occurs in a 5 or 6 foot bed near the top. It is a blue or green clay which weathers to a buff or yellow color, lacks plasticity and disintegrates completely in water. It has been mined for many years in the vicinity of Bath. At Midford it is separated from the overlying Great Oolite Limestones by 17½ feet of unworkable clay, while at Combe Grove there are 11½ feet of intervening clay (Woodward, 1894, p. 242). The commercial clay is presently being worked at the Combe Hay Fuller's Earth Works on Fosse Way, about 3 miles south of Bath. The Foraminifera collected there are shown in Table 7.

The top beds of the Upper Fuller's Earth Clay are exposed at Vernham Wood, about 1½ miles west of the Combe Hay Fuller's Earth Works, where the commercial clay is worked occasionally from small, open cast pits. The following section was obtained from one of these pits (measured by McNichols and Cifelli, 1955):

	feet
a — Rubbly, white oolitic limestone (Base of Great Oolite Limestones)	4—0
b — Green, plastic clay with thin, oolitic marl at the top	2—6
c — Mottled, carbonaceous, dark gray and black plastic clay	1—3
d — Buff, oolitic limestone with 2″ clay band in middle	1—9
e — Green clay, weathering buff, calcareous, nonplastic (probably the top of the commercial Fuller's Earth)	2—4

The Foraminifera are shown in Table 8. Additional Foraminifera from the top part of the Upper Fuller's Earth Clay were obtained on Henley Hill, 1 mile south of Box, where the clay is overlain by the Great Oolite Limestones (Table 9).

The Forest Marble overlies the Great Oolite Limestones (which separate it from the underlying Upper Fuller's Earth Clay) and consists mostly of shelly, oolitic limestones and clays. At Bradford-on-Avon, 5 miles east of Bath, the base of the Forest Marble is represented by the Bradford Clay, consisting of 10 feet of clay with thin layers of argillaceous limestone. At the bottom is a distinctive fossil bed which occurs intermittently at the same horizon from Somerset to Oxfordshire (Arkell, 1933, p. 269). It has been customary to correlate this fossil bed with the *Boueti* Bed of Dorset, although Sylvester-Bradley (1957, p. 27) has suggested a correlation of the Bradford Clay with the *Digona* Beds, a fossiliferous horizon somewhat higher in the Forest Marble of Dorset. The Foraminifera from the Bradford Clay are shown in Table 10.

The Forest Marble is revealed below the surface in the Corsham Monk Quarry, on Monk Lane near Gastard, where the Bath Freestone is mined for building stone. At the bottom of the quarry there are 28 feet of Bath Freestone overlain by 3 feet of the Upper Rag. Above this there are approximately 70 feet of Forest Marble in the shaft of the quarry, consisting of limestones, clays and marls. The clays are wet and weathered, yielding relatively few, poorly preserved Foraminifera (Table 11).

Northern Cotswolds and Oxfordshire

In this region the Great Oolite Series is dominantly of a calcareous facies, composed chiefly of limestones with lesser amounts of clay and marl. The relationships of the strata have been described by Arkell (1951) and Arkell and Donovan (1952).

An almost complete section of the Great Oolite Series is exposed along the railway between Chedworth and Cirencester in East Gloucestershire. The cuttings extend a distance of 8 miles and were described by Richardson (1911a; 1933). The succession includes beds ranging from the Lower Fuller's Earth Clay at the base to the Kemble Beds (Lower Forest Marble) at the top. Although the railway embankments are now partially covered, many of the beds may still be observed. The Hampen Marly Beds and Taynton Stone were not included in Richardson's original description of the section, but were later identified as beds 33-35 and 36, respectively, of Richardson by Arkell and Donovan (1952, p. 246) and Green and Melville (1956, pp. 10-11). The Stonesfield Slate Beds have never been positively identified along the railroad, but Green and Melville (1956, p. 3) believe that they may be present below the Chedworth Station.

Most of the Great Oolite Limestones are exposed in the Hampen railway cuttings, about 5 miles east of Cheltenham. The section was described by Richardson (1929, pp. 102-106), and includes beds ranging from the Lower Fuller's Earth Clay to the White Limestone. The Taynton Stone and the Hampen Marly Beds are particularly well represented in this sequence.

In Oxfordshire the upper part of the Bathonian is represented in the quarry of Kirtlington Cement Works, Kirtlington. The section extends from the White Limestone at the base to the Cornbrash at the top. The lower part of the sequence is exposed in the Sharp's Hill Quarry near Hook Norton, northern Oxfordshire. The section includes the Hook Norton and Chipping Norton Limestones, which replace the Lower Fuller's Earth Clay at the base, and the Lower and Upper Sharp's Hill Beds.

Foraminifera collected from the northern Cotswolds and Oxfordshire are shown in Tables 12-16. Because of the dominantly calcareous nature of the Bathonian in this region suitable foraminiferal samples are difficult to obtain, and portions of the sequence have been but sparsely sampled. No Foraminifera were obtained from the Lower Fuller's Earth Clay or the Cornbrash.

Northamptonshire and Rutland

Foraminifera were collected only from the Upper Estuarine Beds, a series of various colored clays with some sandy shelly beds and limestones. They include both freshwater and marine deposits. Foraminifera are not common (Tables 17-18), but there are numerous ostracods and charophytes.

DISTRIBUTION OF FORAMINIFERA

The present records of species are still too meager to establish the succession of Bathonian Foraminifera in England. Moreover, many of the Jurassic Foraminifera are yet to be described, so that the total ranges of the Bathonian species and their distribution throughout the European province cannot as yet be determined. Consequently, formal subdivision of Bathonian strata based on Foraminifera would hardly be justified at this time. The present records of occurrences of species (Tables 1-18) do reveal that there are 4 faunules that can be recognized in the Dorset and Bath areas. In both of these areas the faunules occur in the same order of superposition and therefore probably contain elements diagnostic of faunizones. North of Bath, where the strata are dominantly of a calcareous facies, the foraminiferal assemblages are generally less rich, containing fewer species. The preservation is often poor and the assemblages are much less distinctive; the faunules cannot be recognized north of Bath.

Faunule A

This faunule occurs in the basal few feet of the Lower Fuller's Earth Clay in Dorset and Bath. The species which have been observed to occur only in this faunule are: *Vaginulina macilenta*, *Frondicularia nodosaria* var. A and *Lenticulina quenstedti* var. A. Although not restricted, *Lenticulina galeata* and *Planularia eugenii* are particularly common here. The following species occur in faunule A and succeeding faunules but have not been recorded from strata older than Bathonian in England: *Dentalina oolithica*, *Lenticulina quenstedti* (*sensu lato*), *L. tricarinella*, *Nodosaria opalini* and *Trochammina haeusleri*. Species of faunule A, not recorded from the succeeding faunules, but characteristic of the Lias are: *Vaginulina clathrata*, *Frondicularia lignaria* and *Nodosaria liassica*.

Faunule B

This faunule has been recognized in the upper beds of the Lower Fuller's Earth Clay, the Fuller's Earth Rock and the *Wattonensis* Beds. Common and characteristic of this faunule, though not restricted to it, are: *Planularia beierana, Lenticulina tricarinella* and *L. munsteri.* Hold-overs from the previous faunule which have not been observed to range above this one are: *Citharina colliezi, Nodosaria* aff. *N. prima, Lenticulina quenstedti* var. B, *L. tricarinella,* and *Planularia eugenii.* Species not occurring in faunule A, but occurring in faunule B and succeeding faunules are: *Dentalina propinqua, Nodosaria pectinata, Frondicularia spissa* and *Vaginulina clathrata cypensa* n. subsp.

Faunule C

This faunule is characteristic of the Upper Fuller's Earth Clay in the Dorset and Bath areas. Common and characteristic, though not restricted to this faunule, are: *Dentalina intorta, Nodosaria opalini, Frondicularia nodosaria, Epistomina stelligera* and *Lenticulina subalata.* Species occurring in faunules C and D but not observed in previous faunules are: *Citharina heteropleura* and *Dentalina* aff. *communis.* Species occurring in this and previous faunules but not faunule D are *Vaginulina harpa* and *Nodosaria pectinata.*

Faunule D

This faunule characterizes the Forest Marble, including the *Boueti* Bed and the Bradford Clay. It is very similar to faunule C, but species of *Lenticulina* are decidedly less common here. The most characteristic aspect of Faunule D is the common, almost restricted occurrence of *Massilina dorsetensis* n. sp. The lowest observed occurrence of this species was in the beds immediately underlying the *Boueti* Bed at Herbury (Sample 30). *Nodosaria clavula* and *Frondicularia intumescens* have not been observed in other faunules, but both of these species are rare. *Vaginulina clathrata cypensa* n. subsp. and *Dentalina subplana* make their last appearances in the *Boueti* Bed and Bradford Clay, the basal beds in which this faunule occurs.

SYSTEMATIC DESCRIPTIONS

Phylum PROTOZOA

Order FORAMINIFERA

Family SACCAMMINIDAE

Genus THURAMMINA Brady, 1879

THURAMMINA TUBEROSA Haeusler

Plate 1, figure 29

Thurammina tuberosa Haeusler, 1890, p. 49, pl. 6, fig. 24; pl. 7, figs. 6-9.

Thuramminopsis canaliculata Haeusler, 1890, p. 50, pl. 7, figs. 1-5; pl. 8, figs. 4-6.

Thurammina papillata, Frentzen (*non* Brady), 1944, p. 322, pl. 17, figs. 1-9.

The present specimens are large, globular and little compressed. The walls are composed of very fine grains, with abundant cement, so that they appear almost calcareous. There are a number of tiny apertures on various parts of the test which have the appearance of pin holes. The shapes are irregular, but the specimens agree with the figures cited.

Family REOPHACIDAE

Genus REOPHAX Montfort, 1808

REOPHAX MULTILOCULARIS Haeusler

Plate 1, figures 6-7

Reophax multilocularis Haeusler, 1890, p. 28, pl. 3, figs. 9-11, 26.

Reophax multilocularis, Bartenstein and Brand, 1937, p. 133, pl. 5, fig. 8; pl. 8, fig. 8a-b; pl. 10, fig. 9; pl. 11a, fig. 5; pl. 15a, fig. 4; pl. 15c, fig. 2.

Reophax scorpiurus, Bartenstein and Brand (*non* Montfort), 1937, p. 134, pl. 4, fig. 7; pl. 5, fig. 9.

This species is very rare, and generally poorly preserved in the present material. The arenaceous wall is moderately coarse, and there are four or five chambers which are slightly higher than broad. The aperture is terminal and rounded. In one specimen the test is slightly curved at the base, but there is no indication of a coil.

Family LITUOLIDAE

Genus FLABELLAMINA Cushman, 1928

FLABELLAMINA ALTHOFFI Bartenstein

Plate 1, figures 25-26

Flabellamina althoffi Bartenstein *in* Bartenstein and Brand, 1937, p. 187, pl. 14a, fig. 8a-b; pl. 15a, fig. 41a-b.

The specimens are higher in relation to breadth, but otherwise compare favorably with the types of the species. The arenaceous wall consists of large grains mounted in abundant calcareous cement, which gives the test a smooth appearance. The grains are generally quartz, but oolites and occasional shell fragments also occur.

This species superficially resembles *Triplasia bartensteini,* and may possibly represent a flattened variant of the latter. No actual transitions between the two forms, however, were observed.

Genus AMMOBACULITES Cushman, 1910

AMMOBACULITES AGGLUTINANS (d'Orbigny)

Plate 1, figure 1

Spirolina agglutinans d'Orbigny, 1846, p. 137, pl. 7, figs. 10-12.

Haplophragmium coprolithiforme, Deeke (*non* Schwager), 1884, p. 20, pl. 1, fig. 5.

Haplophragmium coprolithiforme, Haeusler, 1890, p. 33, pl. 4, figs. 7, 20.

Ammobaculites agglutinans, Franke (*non* Schwager), 1936, p. 127, pl. 12, fig. 25.

Ammobaculites agglutinans, Bartenstein and Brand, 1937, p. 186, pl. 4, fig. 14; pl. 5, fig. 78; pl. 6, fig. 4a-b; pl. 8, fig. 38a-c; pl. 10, fig. 45a-b; pl. 11a, fig. 19a-b; pl. 11b, fig. 28a-b; pl. 12a, fig. 22; pl. 13, fig. 23; pl. 14b, fig. 19.

Bartenstein and Brand (1937, p. 186) state that the wall material is variable in this species. Among the Bathonian forms the wall is remarkably uniform. It is composed of very fine arenaceous particles, and usually contains a large amount of pyrite. The tests are small, and mostly uncoiled.

The species occurs throughout the Bathonian, but individuals are few.

AMMOBACULITES FONTINENSIS (Terquem)

Plate 1, figures 2-5

Haplophragmium fontinense Terquem, 1870b, p. 337, pl. 24, figs. 29, 30.
Ammobaculites fontinensis, Franke, 1936, p. 127, pl. 12, fig. 25.
Ammobaculites fontinensis, Bartenstein and Brand, 1937, p. 186, pl. 5, fig. 79a-b; pl. 6, fig. 43; pl. 8, fig. 37a-d; pl. 10, fig. 44; pl. 11b, fig. 27; pl. 12a, fig. 21a-b; pl. 13, fig. 22.
Ammobaculites fontinensis, Barnard, 1950b, p. 4, pl. 1, fig. 2.

This species shows little selection in the nature of the wall material, which appears to be determined by the nature of the enclosed sediment. The wall is finely to coarsely arenaceous, consisting mostly of quartz grains, but occasionally oolites as well. The degree of coiling is highly variable, and some specimens are practically linear with a minute spire, while others are completely coiled.

Family TEXTULARIDAE

Genus TEXTULARIA Defrance, 1824

TEXTULARIA JURASSICA Gumbel

Textularia jurassica Gumbel, 1862, p. 228, pl. 4, fig. 17a-b.
Textularia franconica Gumbel, 1862, p. 229, pl. 4, fig. 18a-b.
Textularia agglutinans, Blake (*non* d'Orbigny), 1876, p. 472, pl. 17, fig. 37.
Textularia jurassica Paalzow, 1932, p. 94, pl. 4, figs. 21-23.
Textularia agglutinans, Bartenstein and Brand, 1937, p. 182, pl. 14a, fig. 5a-b; pl. 14c, fig. 16; pl. 15a, fig. 40a-c; pl. 15b, fig. 3a-c; pl. 15c, fig. 21a-b.
Textularia jurassica, Seibold and Seibold, 1955, p. 98, pl. 13, fig. 1; text fig. 2a.

Specimens are rare, and agree well with topotypes from the Gumbel locality.

Material deposited at M.C.Z. No. 3306.

Family VERNEUILINIDAE

Genus VERNEUILINA d'Orbigny, 1840

VERNEUILINA MAURITII Terquem

Verneuilina mauritii Terquem, 1866a, p. 448, pl. 18, fig. 18a-b.
Verneuilina georgiae Terquem, 1866a, p. 448, pl. 18, fig. 19a-b.
Verneuilina mauritii, Franke, 1936, p. 126, pl. 12, figs. 22, 23.

Verneuilina mauritii, Bartenstein and Brand, 1937, p. 183, pl. 1a, fig. 22.
Verneuilina mauritii, Cushman, 1946, p. 6, pl. 1, figs. 1-2.
Verneuilina mauritii, Usbeck, 1952, p. 385, pl. 14, fig. 1D.

There is only one specimen and it agrees well with other described forms of this species except that the early part of the test is slightly arched.

Material deposited at M.C.Z. No. 3307.

Family SILICINIDAE

Genus PROBLEMATINA Borneman, 1874

?PROBLEMATINA cf. P. LIASSICA (Jones)

Plate 1, figure 8

One specimen recovered from the *Elongata* Beds at Langton Herring superficially resembles *Problematina liassica* as figured by Macfadyen (1941, p. 19, pl. 1, figs. 9-11). The pillars are well seen on the ventral surface, but the specimen is otherwise poorly preserved and largely replaced by pyrite. The composition of the wall is therefore uncertain; but the granular appearance suggests that it is arenaceous, in which case it would differ from the forms analyzed by Macfadyen.

This species has been previously reported from the Lias only.

Genus HAPLOPHRAGMIUM Reuss, 1860

HAPLOPHRAGMIUM SUPRAJURASSICUM Schwager

Plate 1, figures 9-10

Haplophragmium suprajurassicum Schwager, 1865, p. 92, pl. 2, fig. 1.
Haplophragmium aequale, Bartenstein and Brand (*non* Roemer), 1937, p. 187, pl. 12a, fig. 24; pl. 13, fig. 25a-b; pl. 14a, fig. 9a-b; pl. 14b, fig. 20a-b; pl. 15a, fig. 42.

The walls are generally coarsely arenaceous, but the size of the grains is variable, and occasional specimens are fine grained. There is a slight tendency towards uncoiling, with only one or two chambers beyond the coil.

Genus TRIPLASIA Reuss, 1853

TRIPLASIA BARTENSTEINI Loeblich and Tappan

Plate 1, figure 11

Triplasia variabilis, Bartenstein and Brand (*non* Brady), 1937, p. 185, pl. 14a, fig. 6.

Triplasia bartensteini **Loeblich and Tappan, 1952, p. 8, pl. 1, fig. 4.**

The cross-section of this species is highly variable, which is also characteristic of other species of *Triplasia.* Triradiate forms intergrade imperceptibly into quadrate forms, and I agree with Loeblich and Tappan (1952) in suppressing the genera *Tetraplasia* Bartenstein and *Centenarina* Majzon which are distinguished from *Triplasia* on the quadrate form of the cross-section. Some of the specimens are somewhat compressed, but no transition to the specimens included here in *Flabellamina althoffi* was observed. The height of the spire is also variable, and in some specimens it comprises about half of the test, while in others it is minute, though always conspicuous.

This species is common is certain beds of the Upper Fuller's Earth Clay at Dorset and Vernham Wood, near Bath.

Family MILIOLIDAE

Genus MASSILINA Schlumberger, 1893

In redescribing some of the species of d'Orbigny, Schlumberger (1893) erected the genus *Massilina* for those species of *Spiroloculina* d'Orbigny in which quinquiloculine growth of the test was highly developed. It differs, therefore, from *Spiroloculina* in degree only, and does not possess any distinctive morphological features. The two genera overlap considerably, and as mentioned by Wood and Barnard (1946, p. 83), there would be great difficulty in producing natural groups from specimens involved in these genera. The evolutionary significance of the degree of development of the quinqueloculine growth stage has yet to be demonstrated, and perhaps there is no adequate way of distinguishing the two genera. Pending further study, however, the genus *Massilina* is retained here for those specimens in which the major part of the test is quinqueloculine and the latter part is planar.

MASSILINA DORSETENSIS n. sp.

Plate 1, figures 15-17

Diagnosis. Test small, suboval in outline, slightly biconvex in cross-section, with thin, somewhat transparent wall; eight chambers, each half a whorl in length and increasing in size as added, the first six arranged in a quinqueloculine series, the last two opposite; sutures flush, producing a smooth surface on both sides of test; proloculus minute, spherical; aperture simple, without tooth.

Discussion. All of the proloculi examined were minute, showing no appreciable differences in size, so that microspheric and megalospheric generations are not distinguishable in the present material. The species is distinctive, although it varies considerably in size, and to a lesser extent in thickness and ratio of width to length.

This species most closely resembles *Spiroloculina lanceolata* (Terquem and Berthelin), from which it may be directly descended. It is separated from the latter by the much greater development of the quinqueloculine stage and the lack of a long neck on the last chamber.

This species is common in the Upper Fuller's Earth Clay and Forest Marble, but was not observed at lower horizons.

Greatest length of holotype: .35 mm.
Greatest width of holotype: .18 mm.
Greatest thickness of holotype: .06 mm.
Material deposited at M.C.Z. No. 3311C1.

Genus SPIROLOCULINA d'Orbigny, 1826

SPIROLOCULINA LANCEOLATA (Terquem and Berthelin)

Plate 1, figures 18-19

Quinqueloculina lanceolata Terquem and Berthelin, 1875, p. 84, pl. 7, fig. 7a-b.

Quinqueloculina ovula Terquem and Berthelin, 1875, p. 85, pl. 7, fig. 8a-b.

Quinqueloculina rotundata Terquem and Berthelin, 1875, p. 85, pl. 7, fig. 10a-b.

Quinqueloculina compressa Terquem and Berthelin, 1875, p. 85, pl. 7, fig. 11a-b.

Quinqueloculina contraria Terquem and Berthelin, 1875, p. 85, pl. 7, fig. 12a-b.

The early portion of the test is very small, and consists of a variable number of chambers arranged in a quinqueloculine fashion. The last two chambers are opposite. The final one is characterized by a rather long neck, but this is found only on the better preserved specimens. The resemblances and differences with *Massilina dorsetensis* have already been noted above: it might be added here that *Spiroloculina lanceolata* is generally smaller and slimmer, and the quinqueloculine portion more condensed.

This species is fairly common throughout the English Bathonian.

Family OPHTHALMIDIIDAE

Genus CORNUSPIRA Schultze, 1854

CORNUSPIRA LIASINA Terquem

Plate 1, figures 27-28

Cornuspira liasina Terquem, 1866b, p. 474, pl. 19, fig. 4a-b.

Cornuspira orbicula Terquem and Berthelin, 1875, p. 17, pl. 1, fig. 12a-e.

Cornuspira orbicula, Bartenstein and Brand, 1937, p. 137, pl. 1a, fig. 3a-b; pl. 1b, fig. 3; pl. 2a, fig. 3a-b; pl. 2b, fig. 5; pl. 3, fig. 14; pl. 4, fig. 9; pl. 5, fig. 7; pl. 6, fig. 6a-b; pl. 8, fig. 7a-b; pl. 10, fig. 6a-b; pl. 12a, fig. 2a-b; pl. 12b, fig. 1; pl. 14c, fig. 2.

Cornuspira liasina Bartenstein and Brand, 1937, p. 131, pl. 4, fig. 8.

Coiled, tubular forms are abundant in the English Bathonian, but their relationships are difficult to ascertain because of the minuteness of the test and the imperfect preservation of the wall. Many specimens included here may actually belong to *Spirillina* or *Ammodiscus.* The forms are being investigated at present by Mr. Stuart McNichol of University College, London. Mr. McNichol is using very high magnification, and is studying the wall structure and growth plan of the early part of the test in great detail. His results will undoubtedly shed new light on the relationships of these forms, and the distributional patterns of species of *Cornuspira, Spirillina* and *Ammodiscus* will probably require some revision.

Genus SPIROPHTHALMIDIUM Cushman, 1927

SPIROPHTHALMIDIUM CONCENTRICUM (Terquem and Berthelin)

Plate 1, figures 12-14

Spiroloculina concentricum Terquem and Berthelin, 1875, p. 80, pl. 7, figs. 1-4.

Spirophthalmidium tenuissimum Paalzow, 1932, p. 100, pl. 5, figs. 11-13.
Spirophthalmidium concentricum, Franke, 1936, p. 123, pl. 12, figs. 15, 17.
Spirophthalmidium concentricum, Bartenstein and Brand, 1937, p. 181, pl. 2b, figs. 37, 38; pl. 4, fig. 16; pl. 5, fig. 71a-b; pl. 8, fig. 36; pl. 13, fig. 21; pl. 15a, fig. 39a-b.

The proloculus and early spiral are minute, but under ordinary magnifications the specimens can be seen to lack clearly defined ophthalmid structure. The validity of the genus has been questioned, but I agree with Wood and Barnard (1946, p. 87) that the name should be retained until the relationships of the Ophthalmidiidae are better understood pending further study of the living representatives.

Family TROCHAMMINIDAE

Genus TROCHAMMINA Parker and Jones, 1859

TROCHAMMINA HAEUSLERI (Galloway)

Plate 1, figures 21-22

Valvulina triangularis, Haeusler (*non* d'Orbigny), 1890, p. 75, pl. 12, figs. 23, 24.
Valvulina conica, Haeusler (*non* Parker and Jones), 1890, p. 76, pl. 12, figs. 27-35.
Tritaxis haeusleri Galloway, 1933, pl. 19, fig. 2a-b.
Valvulina (?) *haeusleri,* Cushman, 1937, p. 4, pl. 1, fig. 1.
Valvulina (?) sp. Cushman, 1937, pl. 1, figs. 2-4.

Test small, finely arenaceous with much cement, conical, chambers arranged in a trochoid spiral, about four to a whorl in the early portion, later only three; sutures flush; proloculus tiny, globular, alternate generations not apparent; aperture a poorly defined slit at base of last chamber in the umbilical region.

Haeusler did not figure a side view of this form which Galloway later used as the type of the species. Galloway interpreted the test as being flat, and apparently on this basis referred the species to *Tritaxis.* In the present specimens the height is variable, but the majority of tests are distinctly conical and only occasional ones are flattened. They agree very well with Haeusler's figures, and on the basis of growth plan and aperture it seems best to refer the species to *Trochammina.*

The species clearly differs from *Valvulina triangularis* Parker and Jones, a recent form, and Galloway's usage of the name is otherwise adhered to.

TROCHAMMINA GLOBIGERINIFORMIS (Parker and Jones) 1863

Plate 1, figures 23-24

Haplophragmium globigeriniformis, Haeusler (*non* Parker and Jones), 1890, p. 36, figs. 193-195.

Trochammina globigeriniformis, Cushman, 1920, p. 78, pl. 16, figs. 5-6 (1918-31).

Trochammina globigeriniformis, Seibold and Seibold, 1953, p. 46, text figs. 5-6.

There are three or four chambers in the last whorl and the aperture is not visible. The amount of cement is variable, and some specimens are distinctly arenaceous while others are almost completely calcareous. The chambers are generally bulbous, but occasionally they are compressed, probably due to squashing.

The Jurassic forms are generally smaller than the recent counterparts, but otherwise they are morphologically identical. This appears to be an example of a very long-ranged species.

Specimens are rare, but occur sporadically throughout the Bathonian.

TROCHAMMINA sp.

Plate 1, figure 20

The material consists of two specimens which resemble *Trochammina globigeriniformis,* but are less trochoid and are flatter. They are also similar to *Trochammina canariense* (d'Orbigny) figured by Haeusler (1890, p. 34, pl. 4, figs. 1-3), but these are broader and have fewer chambers in the last whorl.

Family LAGENIDAE

Genus LENTICULINA Lamarck, 1804

LENTICULINA GALEATA (Terquem)

Plate 2, figures 15-17

Cristellaria galeata Terquem, 1870a, p. 444, pl. 16, fig. 15a-b.

Cristellaria subangulata, Bruckman, (*non* Reuss), 1904, p. 22, pl. 3, fig. 9.

Test smooth, finely perforate, slightly involute, generally biconvex with slight depression in umbilical area, some specimens triangular in cross-section; periphery rounded, mostly close coiled, but occasionally uncoiled in later portion; chambers numerous, six to ten in the last whorl, increasing in size as added, last ones inflated; sutures deeply depressed, with moderately strong ribs along the margins which extend to the keel; well developed keel throughout but indented at the sutures; aperture radiate, terminal, projecting slightly at peripheral margin.

Most of the tests are biconvex, but some have practically parallel sides, while others are triangular in cross-section, as in the genus *Saracenaria.* The ribbing along the margins of the sutures also exhibits some modification. Most often the ribs are quite strong, but occasionally they are weakly developed, and on one specimen observed they were completely inconspicuous. Occasionally a weak circular rib is developed, as in *L. quenstedti,* and except for the depression of the sutures such specimens are difficult to distinguish from the latter species .

Terquem's figure of this species does not show the ribs along the margins of the depressed sutures. At the Muséum d'Histoire Naturelle, Paris there are two specimens of this species in the Terquem collection, and ribs are well developed in both.

This species is common in the Lower Fuller's Earth Clay, but isolated specimens appear throughout the remainder of the Bathonian.

LENTICULINA MULTANGULOSA (Schwager)

Plate 2, figure 14

Cristellaria multangulosa Schwager, 1865, p. 126, pl. 6, fig. 3.
Lenticulina (Astacolus) multangulosa, Seibold and Seibold, 1953, p. 56, pl. 5, fig. 12.

The angular periphery of this species is characteristic. Schwager's figure shows six chambers, and the last two are decidedly uncoiled, arranged in a linear series. Otherwise the present specimens agree well with the original figure.

LENTICULINA MUNSTERI (Roemer)

Plate 2, figures 3-5

Robulina munsteri Roemer, 1839, p. 48, pl. 20, fig. 29.
Cristellaria inflata Schwager, 1865, p. 125, pl. 6, fig. 16.

Cristellaria (*Lenticulina*) *munsteri*, Bartenstein and Brand, 1937, p. 174, pl. 3, fig. 30a-b; pl. 4, fig. 69a-e; pl. 6, fig. 34a-d; pl. 9, fig. 49a-e; pl. 10, fig. 38a-b; pl. 11a, fig. 13a-d; pl. 11b, fig. 19a-d; pl. 12a, fig. 16a-b; pl. 12b, fig. 15a-e; pl. 13, fig. 36; pl. 14b, fig. 14a-c; pl. 14c, fig. 13a-b; pl. 15a, fig. 34a-c; pl. 15c, fig. 19a-c.

Cristellaria (*Astacolus*) *matutina*, Bartenstein and Brand (*non* d'Orbigny), 1937, p. 172 (pars), pl. 4, fig. 79; pl. 5, fig. 53; pl. 6, fig. 33.

Cristellaria munsteri, Macfadyen, 1941, p. 31, pl. 2, fig. 23a-b.

Cristellaria matutina, Macfadyen, 1941, p. 30, pl. 2, fig. 22.

Lenticulina munsteri, Barnard, 1950b, p. 7, pl. 2, fig. 1.

Lenticulina (*Lenticulina*) *munsteri*, Seibold and Seibold, 1955, p. 104, text fig. 4a-c.

Lenticulina (*Astacolus*) *matutina*, Seibold and Seibold, 1955, p. 108, text fig. 4k-l.

Many specimens have a slight keel, the presence of which appears to be determined partially by preservation. Possibly the Jurassic forms referred to as *Lenticulina cultrata* (Montfort) should be included here, as this species is distinguished from *L. munsteri* only by the presence of the keel. However, the keels on the English Bathonian specimens are always small, and never highly developed as in the described forms of *L. cultrata*.

This species occasionally exhibits a marked tendency to uncoil, and in some assemblages there occur transitions from the typical, tightly coiled types to linear forms with a small spire.

In the uncoiled individuals the sutures tend to become depressed in the last stages, and the last chambers are sometimes bulbous. The uncoiled individuals are identical with some of those of *Lenticulina matutina* (d'Orbigny), and probably many specimens identified as this latter species are actually variants of *L. munsteri*.

LENTICULINA QUENSTEDTI (Gumbel)

Plate 2, figures 6-7

Cristellaria quenstedti Gumbel, 1862, p. 226, pl. 4, fig. 2a-b.

Cristellaria polonica Wisniowski, 1890, p. 222, pl. 10, fig. 3.

Cristellaria quenstedti, Klahn, 1921, p. 49, pl. 2, figs. 16, 18-25.

Cristellaria quenstedti, Paalzow, 1932, p. 102, pl. 6, figs. 3-5.

Cristellaria (*Lenticulina*) *quenstedti*, Bartenstein and Brand, 1937, p. 177, pl. 11a, fig. 16a-c; pl. 11b, fig. 23a-c; pl. 12a, fig. 19a-d; pl. 12b, fig. 7a-c; pl. 13, fig. 39a-c; pl. 14, fig. 17a-b; pl. 15a, fig. 36a-c; pl. 15c, fig. 20a-b.

Lenticulina quenstedti Barnard, 1952, p. 339, text fig. A-6.
Lenticulina (*Lenticulina*) *quenstedti* Seibold and Seibold, 1955, p. 105, pl. 13, fig. 3.

This common Jurassic species has been described many times. Most characteristic are the raised sutural ribs which converge at the umbilical area and are connected by a circular rib. The specimens figured by Bartenstein and Brand have ribs which are beaded, and differ in this respect from those recorded here and most other described forms of this species. The difference is not considered taxonomically significant. The ribbing, however, is variable and Bartenstein and Brand (1937, p. 177) note that in the Middle Dogger of Germany this species appears to be transitional to *Lenticulina tricarinella* (Reuss). In the present material some specimens lack a clearly defined circular rib, and have sharp sutural ribs extending to the periphery. Such specimens are very similar to *L. tricarinella,* but no actual transition was observed, as the forms included here consistently lack the lateral keels of *L. tricarinella.*

This species is common in the English Bathonian, appearing at the base of the Lower Fuller's Earth Clay, which is the earliest recorded occurrence in England.

LENTICULINA QUENSTEDTI (Reuss) var. A n.var.

Plate 2, figures 9-10

Test large, compressed, with rugose surface; periphery rounded, with distinct keel; chambers numerous, seven or eight visible in the last whorl, increasing in size as added; sutures gently curved, raised along the greater part of their length, and meeting at umbonal area; oblique costae weak and poorly developed near peripheral margin in last part of test; aperture peripheral, radiate, slightly projecting.

The test is larger, and the surface is more rugose than in the typical forms. The circular rib is not as well developed, and oblique costae are generally present in the later chambers, which was not observed in *Lenticulina quenstedti.*

The distribution of this variety appears to be restricted. It was recovered only from the Lower Fuller's Earth Clay at Dorset and at Midford, in the Bath area.

LENTICULINA QUENSTEDTI (Reuss) var. B n.var.

Plate 2, figure 8

Test stout, slightly biconvex, involute, slightly longer than broad; periphery sub-rounded; chambers numerous, six to eight visible in the last whorl, increasing in size as added; sutures curved, strongly limbate, extending from periphery to umbilical area; thin keel, not visible on all specimens; umbilical area depressed, partially filled with beads of calcite, sometimes with partially developed circular rib connecting sutures; aperture radiate, projecting slightly from peripheral margin.

This variety differs from the typical forms in being more involute and robust. The circular rib connecting the sutures is much less developed, and the sutures are generally more limbate.

The variety occurs sporadically throughout much of the Bathonian. It is most common in the *Wattonensis* Beds at Dorset.

LENTICULINA SUBALATA (Reuss)

Plate 2, figures 1-2

Cristellaria subalata Reuss, 1854, p. 68, pl. 25, fig. 13.

Cristellaria casis, Jones and Parker (*non* Fitchel and Moll), 1860, p. 457, pl. 20, fig. 41.

Cristellaria helios Terquem, 1870a, p. 445, pl. 16, figs. 19-21.

Cristellaria subalata, Franke, 1936, p. 115, pl. 11, fig. 19.

Cristellaria (*Lenticulina*) *subalata,* Bartenstein and Brand, 1937, p. 176, pl. 6, fig. 35a-c; pl. 9, fig. 54a-c; pl. 10, fig. 41a-b; pl. 11a, fig. 15a-b; pl. 11b, fig. 22a-b; pl. 12a, fig. 18a-c; pl. 12b; fig. 16; pl. 13, fig. 38a-c; pl. 14b, fig. 16a-b; pl. 15a, fig. 35a-b.

Cristellaria (*Lenticulina*) *subalata* form A Bartenstein and Brand, 1937, p. 177, pl. 9, fig. 55a-f; pl. 10, fig. 42a-b.

This species is similar to *L. munsteri,* but has raised and generally broader sutures. It also resembles *Lenticulina varians* (Borneman), but besides having the raised sutures, is more biconvex and rounder in cross-section than is this latter species.

Specimens of *Cristellaria helios* in the Terquem collection are identical with the present ones. However, other identical specimens in the collection are scattered among various dissimilar species of *Cristellaria* (*sensu lato*) type, some bearing little resemblance to the figures which are supposed to illustrate them. Consequently, a comprehensive synonymy is difficult.

The type of this species is from the Cretaceous of the eastern Alps, but the Jurassic forms appear to be morphologically identical. It occurs commonly throughout the English Bathonian.

LENTICULINA SOWERBYI (Schwager)

Cristellaria sowerbyi Schwager, 1867, p. 660, pl. 34, fig. 18.
Cristellaria sowerbyi Deeke, 1886, p. 322, pl. 2, fig. 34.

In some specimens the later chambers overlap on one side, producing a test that is trochoid, and similar to the growth plan that is found in *Darbyella*. The sutures are most generally flush, but they tend to become depressed in the later chambers, a tendency noted in many lagenid species.

LENTICULINA TRICARINELLA (Reuss)

Plate 2, figures 20-23

Cristellaria (*Cristellaria*) *tricarinella* Reuss, 1863a, p. 68, pl. 7, fig. 9; pl. 12, figs. 2-4.
Cristellaria polymorpha Terquem, 1870a, p. 454, pl. 19, figs. 1-30; pl. 21, figs. 1-30.
Cristellaria tricarinella, Paalzow, 1917, p. 240, pl. 56, fig. 6.
Cristellaria tricarinella, Klahn, 1921, p. 50, pl. 21, figs. 7-10.
Planularia feifeli Paalzow, 1932, p. 105, pl. 6, figs. 11, 12.
Cristellaria tricarinella, Macfadyen, 1935, p. 15, pl. 1, fig. 18a-b.
Cristellaria (*Astacolus*) *tricarinella*, Bartenstein and Brand, 1937, p. 173, pl. 13, fig. 35a-b; pl. 14b, fig. 13a-b; pl. 15a, fig. 33a-b; pl. 15c, fig. 18.
Cristellaria tricarinella, Frentzen, 1941, p. 353, pl. 5, figs. 13, 14.
Lenticulina (*Planularia*) *tricarinella*, Seibold and Seibold, 1953, p. 54, pl. 4, fig. 5.

This common and distinctive species has been either described or recorded many times from the Jurassic. The sharp, sutural ribs joining the lateral keels are characteristic. Occasionally, the lateral keels are incompletely developed, appearing instead as impersistent costae along the margins of the test. Typically, the tests are tightly coiled, with only one or two chambers extending beyond the spire. In occasional assemblages, however, all degrees of coiling occur, and in some tests the chambers are arranged in linear or curved series, with the spiral part forming a small, minor portion of the test. Some of the linear types tend to become triangular in cross-section and except for their mutual relationships with the rest of the specimens could be confused with *Saracenaria.*

On some specimens, faint, oblique costae are present between the sutural ribs of the last two chambers. The number and strength of these are very variable, and they most generally occur on those specimens which lack the clearly defined lateral keels.

I have examined a large number of specimens of *Cristellaria polymorpha* Terquem in the Terquem collection, and agree with Macfadyen (1935, p. 15) that this species is a synonym of *Lenticulina tricarinella* (Reuss). The intricate scroll pattern illustrated by Terquem was not observed on any of the specimens. It was observed, however, that when the slides of the Terquem collection were viewed from the underside, irregular streaks in the mounting medium appeared to cover many of the specimens in intricate, scroll-like patterns. Possibly Terquem confused these patterns with ornamentation.

Franke (1936) illustrated a specimen of *Cristellaria polymorpha* Terquem with peculiar markings on the wall which, though less elaborate, are similar to Terquem's scroll-like patterns. His figure otherwise appears to be identical with *Lenticulina tricarinella* (Reuss). The markings may be due to foreign matter on the test, or possibly they may be indistinct, oblique costae.

This species has not been previously described from England. It occurs in the lowermost Fuller's Earth Clay, and the Lower Bathonian is the earliest known English occurrence. This species is a common and characteristic form in the Middle Jurassic of Europe, and Bartenstein and Brand (1937, p. 173) record the earliest occurrence in northwest Germany from the *Parkinsoni* Schichten (Upper Bajocian). If Franke's *Cristellaria polymorpha* (recorded from the Lias Gamma) is a synonym, the range in Germany would extend into the Lower Jurassic. Bartenstein and Brand, however, do not consider Franke's form a synonym.

LENTICULINA TRICARINELLA (Reuss) var. A n.var.

Plate 2, figure 24

Test small, compressed, finely perforate, incompletely coiled, three to five chambers arranged in gently curved series, increasing in size as added; keel single, well developed, extending without interruption over entire peripheral margin; striae absent or faintly developed in last chambers; sutures raised in sharp ridges, connecting with keel; aperture radiate.

This variety lacks the marginal keel and is generally smaller than typical members of the species. It occurs rarely in the Upper Fuller's Earth Clay and *Wattonensis* Beds of the Dorset Coast.

LENTICULINA TURGIDA (Schwager)

Plate 2, figures 18-19

Cristellaria turgida Schwager, 1865, p. 127, pl. 6, fig. 4.
Cristellaria informis Schwager, 1865, p. 128, pl. 6, fig. 8.
Cristellaria inflata, Wisniowski (*non* Schwager), 1890, p. 227, pl. 10, fig. 13a-b.
Lenticulina (*Astacolus*) *matutina informis*, Seibold and Seibold, 1956, p. 119, pl. 7, fig. 13; text fig. 4e-g.

There is one microsphere in the present material, and the specimen is larger than the others. It consists of eight chambers, and the last one overlaps on one side, as in *Darbyella*.

There is good agreement between specimens included here and the figures of Seibold and Seibold who studied topotype material from which Schwager originally described the species. The English Bathonian forms, however, show less tendency to uncoil.

LENTICULINA VARIANS (Borneman)

Plate 2, figures 11-13

Cristellaria varians Borneman, 1854, p. 41, pl. 4, figs. 32-34.
Cristellaria inquisita Terquem, 1870a, p. 444, pl. 16, figs. 16-18.
Cristellaria (*Lenticulina*) *varians* Borneman var. *recta* Franke, 1936, p. 113, pl. 11, fig. 12.
Cristellaria (*Lenticulina*) *varians*, Bartenstein and Brand, 1937, p. 176, pl. 1a, fig. 18; pl. 2a, figs. 16, 20; pl. 3, fig. 31; pl. 5, fig. 60; pl. 8, fig. 53a-b.

Cristellaria (Lenticulina) varians form A Bartenstein and Brand, 1937, p. 176, pl. 10, fig. 40a-d; pl. 11a, fig. 14a-d; pl. 11b, fig. 21a-b.

This species most closely resembles *Lenticulina munsteri* (Roemer), and is distinguished by the more compressed nature of the test and the narrower, slightly depressed sutures.

Borneman's figures are not too clear, nor do they indicate the possible variation of this species. Consequently, various interpretations are possible and there are a variety of forms in the literature bearing this name, many of which are distinct from those included here. Synonymies are uncertain and the types need to be re-studied.

Terquem showed only outline drawings of *Cristellaria inquisita,* but the specimens in the Terquem collection are identical with the ones recorded here.

Genus PLANULARIA Defrance, 1824

PLANULARIA ANCEPS (Terquem)

Plate 3, figures 14-15

Cristellaria anceps Terquem, 1870a, p. 428, pl. 9, figs. 11-21.
Cristellaria dolium Terquem, 1870a, p. 431, pl. 9, fig. 29a-b.

There is one microsphere in the present material, and it is identical with the megalospheres, except that the large proloculus is represented by several small chambers which form an incomplete coil.

Terquem illustrated a variety of specimens of this species, including forms with depressed sutures and a globular proloculus. He later extended the species (Terquem, 1883, p. 350, pl. 38, figs. 18-28; pl. 39, figs. 1-2) to include a variety of forms which bear very little resemblance to the earlier figures. Many of the later figures seem to represent aberrant or immature specimens, and probably belong to other species. Even as originally described, the species probably consists largely of an unrelated group of specimens. However, there is good agreement between my specimens and some of Terquem's figures (particularly pl. 9, fig. 12), as well as the specimens from the Terquem collection, so that there is at least partial identity.

PLANULARIA BEIERANA (Gumbel)

Plate 3, figures 1-10; text figure 3.

Marginulina beierana Gumbel, 1862, p. 221, pl. 3, fig. 20a-b.

Cristellaria jurassica Gumbel, 1862, p. 224, pl. 3, fig. 25a-c.

Cristellaria semiinvoluta Terquem, 1870a, p. 435, pl. 11, figs. 1-30; pl. 12, figs. 1-30.

Cristellaria suturalis Terquem, 1870a (*non* Terquem, 1866a), p. 434, pl. 10, figs. 19-24.

Cristellaria semiinvoluta var. *plana* Deeke, 1886, p. 317, pl. 2, fig. 35.

Planularia semiinvoluta, Paalzow, 1932, p. 105, pl. 6, figs. 13, 14, 20, 21.

Cristellaria (Planularia) cordiformis, Bartenstein and Brand (*non* Terquem), 1937, p. 169, pl. 6, fig. 30a-b; pl. 9, fig. 43a-e; pl. 10, fig. 30a-d; pl. 12a, fig. 10; pl. 12b, fig. 11a-b; pl. 13, fig. 29a-c; pl. 14b, fig. 10; pl. 15a, fig. 28a-b.

Cristellaria (Planularia) crepidula, Bartenstein and Brand (*non* Fitchel and Moll), 1937, p. 169, pl. 2a, fig. 18a-b; pl. 3, fig. 48; pl. 4, fig. 76; pl. 5, fig. 74; pl. 9, fig. 45a-e; pl. 10, fig. 31; pl. 11a, fig. 11; pl. 11b, fig. 16a-b; pl. 12a, fig. 12a-d; pl. 12b, fig. 12a-b; pl. 13, fig. 31; pl. 14b, fig. 11; pl. 14c, fig. 12; pl. 15a, fig. 30; pl. 15c, fig. 15a-b.

Cristellaria (Planularia) filosa, Bartenstein and Brand (*non* Terquem), 1937, p. 169, pl. 4, fig. 77; pl. 9, fig. 44; pl. 11a, fig. 15a-b; pl. 12a, fig. 11; pl. 13, fig. 31; pl. 15a, fig. 29a-c, pl. 15c, fig. 14a-b.

Lenticulina (Planularia) cordiformis, Bartenstein, 1948, pl. 2, figs. 13-15.

Lenticulina (Planularia) crepidula, Bartenstein, 1948, pl. 2, figs. 20-21.

Falsopalmula deslongchampsi, Bartenstein (*non* Terquem), 1948, pl. 1, figs. 6-7; pl. 2, fig. 10.

Falsopalmula obliqua, Bartenstein (*non* Terquem), 1948, pl. 2, figs. 11-12.

Lenticulina (Planularia) beierana, Seibold and Seibold, 1955, pl. 13, fig. 7; text fig. 4e, f.

Test small, much compressed, with thin, transparent wall; chambers, numerous, five to eleven in number, first four or five arranged in a loose coil, remainder arranged in a linear or gently curved series, last ones sometimes equitant; proloculus in megalosphere large, suboval, generally subparallel to longitudinal axis of test; sutures flush, depressed or sometimes raised in form of marginal ribs; aperture terminal, radiate.

Microspheres are rare, occurring in about one out of eight specimens. They do not differ from the megalospheres, except that the proloculus is smaller, and there are a greater number of chambers. The size of the proloculus is quite variable, but is always large in relation to the size of the test. There is no evidence to suggest trimorphism within this species, as the prolocular size differences are transitional among the megalospheres.

The shape of the test is highly variable, and is related to the degree of overlap of the chambers on the prolocular area. This relationship has been previously described in *Planularia pauperata* Jones and Parker by Barnard (1950b, p. 11).

The raised sutures were observed only on specimens from the *Wattonensis* Beds, where this species exhibits an extremely high degree of variability. All gradations from depressed to flush, to limbate, can be observed. Not only is this character variable from specimen to specimen, but in a single individual all three types of suture may be found.

The transitional nature of the typical uncoiled growth plan to the equitant or flabelline chamber form is illustrated in Figure 3A-N. All specimens were recovered from a single sample from the *Wattonensis* Beds on the Dorset Coast. The equitant chambers vary in number, size and degree of symmetry, reflecting a high instability of the character. In some instances the change in growth plan is marked (Figure 3I), while in others it is accomplished gradually, by progressive overlap of the later chambers on the oral margin (Figure 3G). Growth is sometimes irregular, and in Figure 3K the ninth chamber partially reverts to the linear arrangement by failing to overlap on the oral margin. In Figure 3N the equitant chambers have developed before the test has uncoiled, and the longitudinal axis of the test is shifted towards the adoral margin. This specimen is also unusual in that the proloculus is elongated in a direction approximately perpendicular to the longitudinal axis of the test, contrary to other specimens in which the proloculus is elongate parallel to the long axis of the test.

This species is highly variable in almost all observable morphological characters, and the problem of deciding which specific name to use is difficult. All of the diverse types illustrated here are connected by integrading forms, and there appears to be no logical way of separating them on the basis of morphology or distribution. They are therefore regarded here as a single, highly variable species. I have examined topotypes of *Planularia beierana*, and there is good agreement with these specimens,

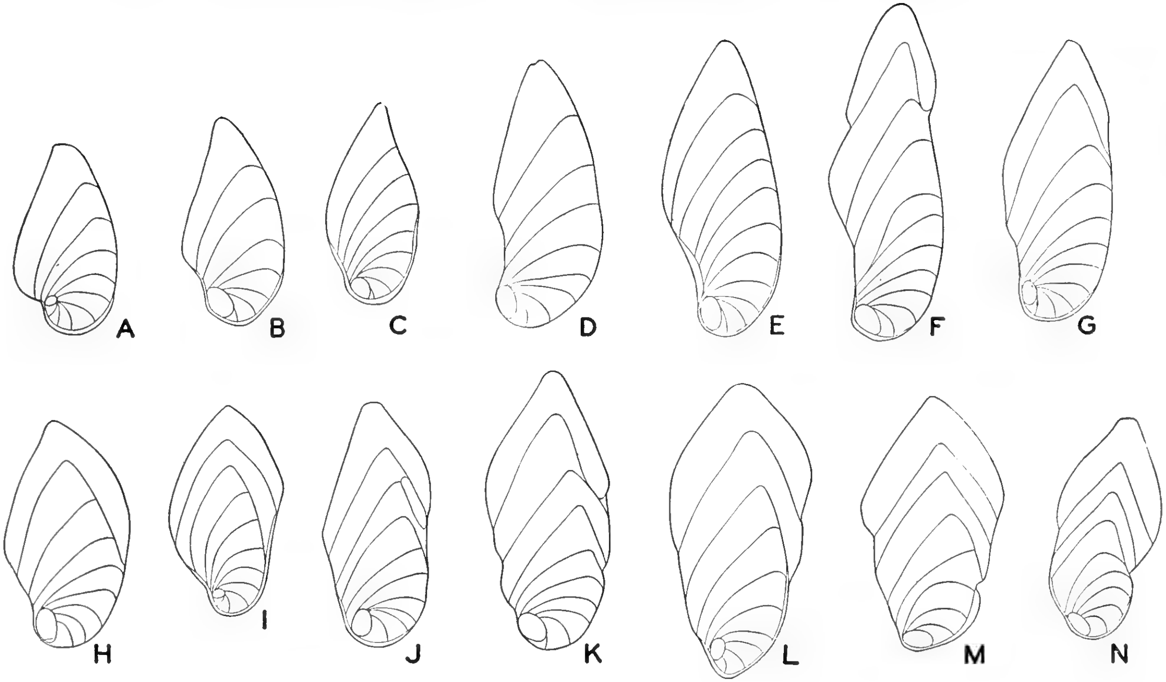

Figure 3. Variation of *Planularia beierana* (Gumbel). All specimens are from sample DoEm4, *Wattonensis* Beds, Dorset.

except that the topotypes tend to be broader, and the later chambers generally overlap more on the prolocular area. They may possibly form a link with *Planularia pauperata* Jones and Parker. The specimens of *Planularia pauperata* from Chelaston, Derby, in the Jones and Parker collection at the British Museum (Natural History) appear to be distinct from the present ones. They are generally more robust, broader, and the chambers show more overlap. There are only three specimens in the collection, and possibly a more numerous suite would show transitions to the present ones. However, the specimens of *P. pauperata* from the Lias of Byfield described by Barnard (1950b, p. 10, pl. 2, fig. 7) are identical with those from Chelaston, Derby, and are distinct from the Bathonian forms.

Cristellaria semiinvoluta Terquem appears to represent a heterogeneous group of specimens. Unfortunately, many of the specimens of this species in the Terquem collection do not agree well with the figures that presumably illustrate them, and without the original types it is not possible to properly analyze this species. There is no doubt, however, that in part, at least, this species is a synonym of *Planularia beierana*. The striate forms do not seem to belong here, but this cannot be determined until the types have been recovered, or the type locality re-examined. The large number of forms illustrated by Bartenstein and Brand (and included here in this species) do not appear distinct to me, even on the basis of those authors' material. The variational patterns of *P. beierana* in northwest Germany are similar to the ones encountered in the English Bathonian. However, the form described as *Cristellaria* (*Planularia*) *cordiformis* Terquem may possibly be transitional to *P. pauperata*. Forms identical with the ones described by Bartenstein as *Falsopalmula deslongchampsi* (Terquem) and *Falsopalmula obliqua* (Terquem), are included here because of the transitional nature and intimate association of these identical forms with typical forms of *Planularia beierana*, in the English Bathonian.

This species is common in the English Bathonian, and individuals are generally numerous. The variational patterns are sporadic, but by far the greatest ''bursts'' occur in the *Wattonensis* Beds at Dorset. Here the sutures show all gradations from distinctly depressed to rather prominent marginal ribs. The shapes are highly variable, and equitant chambers are more common than at any other locality. Equitant chambers were also observed in specimens from the Lower Fuller's Earth Clay at Dorset and Midford, and from the Bradford Clay in the Monk quarry at Corsham.

PLANULARIA BREONI (Terquem)

Plate 3, figure 11

Cristellaria breoni Terquem, 1864a, p. 420, pl. 9, figs. 4a, b.

Cristellaria (*Astacolus*) *breoni*, Bartenstein and Brand, 1937, p. 173, pl. 4, fig. 75; pl. 5, fig. 56.

Cristellaria (*Astacolus*) *radiata*, Bartenstein and Brand (*non* Terquem), 1937, p. 172, pl. 5, fig. 58; pl. 12b, figs. 14a-c; pl. 13, figs. 34a-b.

Cristellaria (*Astacolus*) *quadricostata*, Bartenstein and Brand (*non* Terquem), 1937, p. 173, pl. 3, fig. 47; pl. 4, fig. 71; pl. 5, fig. 57.

This species resembles *Planularia eugenii* (Terquem) in its numerous striations which completely cover the sides of the test. However, *P. breoni* is more rounded in cross-section, has broader chambers and the sutures are more depressed.

PLANULARIA EUGENII (Terquem)

Plate 3, figures 16-17

Cristellaria eugenii Terquem, 1864a, p. 414, pl. 9, fig. 16a-b.

Cristellaria arietis Issler, 1908, p. 81, pl. 5, figs. 255-260.

Cristellaria crepidula (Fitchel and Moll) var. *striata* Issler, 1908, p. 82, pl. 5, figs. 255-266; pl. 6, figs. 266-268.

Cristellaria (*Planularia*) *eugenii*, Bartenstein and Brand, 1937, p. 170, pl. 3, fig. 56; pl. 10, fig. 33a-b; pl. 12a, fig. 13.

One microsphere was observed, and it differed from the megalospheres only in the greater number of chambers in the coiled portion of the test. The species is highly variable in shape, with specimens ranging from elongate with parallel margins, to broad, stubby ones in which the margins diverge. The number of ribs range from ten to twenty and in strength from faint striations to prominent ribs.

This species is similar to *Planularia beierana* (Gumbel), but is distinguished by the presence of ribs and the shape of the chambers which are much lower in relation to the breadth than in the latter species.

Terquem described this species from the Lias. The one specimen available from the Terquem Lias collection in the Muséum d'Histoire Naturelle is much larger and more robust than the present ones, but otherwise they compare well, and I consider them identical. Terquem included many striate forms in *Cristellaria semiinvoluta* and *Cristellaria subinvoluta* and possibly many of these belong here as well.

PLANULARIA INCONSTANS (Schwager)

Cristellaria inconstans Schwager, 1867, p. 658, pl. 34, fig. 15.
Cristellaria dialatata Wisniowski, 1890, p. 211, pl. 9, fig. 10.
Cristellaria dorsoarcuata Wisniowski, 1890, p. 211, pl. 9, fig. 11.
Cristellaria (*Astacolus*) *inconstans*, Bartenstein and Brand, 1937, p. 171; pl. 10, fig. 34a-c.

This species resembles *Planularia protracta* (Borneman), but can be distinguished by the broader, lower chambers and the absence of a coil.

Specimens are rare and were recovered only from the *Wattonensis* Beds.

Material deposited at M.C.Z. No. 3333.

PLANULARIA PROTRACTA (Borneman)

Plate 3, figures 12-13

Cristellaria protracta Borneman, 1854, p. 39, pl. 4, fig. 27a-b.
Cristellaria lista Borneman, 1854, p. 39, pl. 4, fig. 28.
Cristellaria protracta, Macfadyen, 1941, p. 32, pl. 2, fig. 24.

This species is similar to *Planularia beierana* (Gumbel), but is distinguishable by the more oval, less compressed test and by the much greater curvature of the peripheral margin at the base of the test.

PLANULARIA sp. A

Test compressed, slightly twisted; thin walled, transparent; chambers numerous, the first three forming incomplete coil, the remaining four arranged in a linear series, increasing regularly and rapidly in height as added, moderately in breadth; sutures depressed, particularly in later chambers; aperture terminal, radiate.

The specimens are similar in outline to *Planularia pauperata* Jones and Parker, but the test is twisted, and the last chambers tend to be bulbous. The material consists of three specimens from three separate localities in the Upper Fuller's Earth Clay.

Material deposited at M.C.Z. No. 3335.

PLANULARIA sp. B

Plate 3, figure 18

Several poorly preserved specimens are included here which consist of linear tests with low, broad chambers, arched in the early portion, but not actually coiled. The sutures are depressed and slightly curved. The shapes vary from broad, short forms, to long, slim ones. The most distinctive feature is the presence of an elevated border on both margins of the test, against which the sutures abut. This feature is characteristic of *Planularia arguta* Reuss, a Cretaceous form. The present specimens are similar to fragments identified as this species and described by Blake (1876, p. 464, pl. 19, fig. 10), from the Lias of Yorkshire. The Bathonian material, however, is poorly preserved, and the raised margins, which are not present on all of the specimens, may be due to squashing in the central portions of the tests.

The forms resemble *Vaginulina legumen* (Linné), but are smaller and flatter; in side view they tend to be more triangular.

The specimens are rare, and occur only in the Cotswolds, Oxford and Northampton areas.

Genus MARGINULINA d'Orbigny, 1826

MARGINULINA DESLONGCHAMPSI Terquem

Plate 3, figure 21

Marginulina deslongchampsi Terquem, 1864a, p. 188, pl. 8, fig. 8a-b.

Marginulina oolithica, Franke (*non* Terquem), 1936, p. 74, pl. 7, fig. 17a-b.

Marginulina oolithica, Bartenstein and Brand, 1937, p. 160, pl. 2a, fig. 11; pl. 2b, fig. 27; pl. 3, fig. 38; pl. 6, figs. 17, 26; pl. 8, fig. 26a-b; pl. 10, fig. 24.

Specimens from the English Bathonian are somewhat less curved in the initial portion of the test than are shown in the figures of Terquem, but are still distinctly marginuline, and otherwise agree well with the figures.

The shape of the chambers is variable and in some specimens the chambers are bulbous and twisted slightly from the longitudinal axis. The degree of curvature is also variable, and some tests are almost dentaline.

This species is rare, and occurs only in the Lower Fuller's Earth Clay and *Wattonensis* Beds on the Dorset Coast.

MARGINULINA TERQUEMI d'Orbigny

Plate 3, figures 19-20

Marginulina terquemi, Terquem (*non* d'Orbigny), 1858, p. 609, pl. 3, fig. 1a-c.

Marginulina glabra, Haeusler (*non* d'Orbigny), 1890, p. 106, pl. 14, figs. 35-40, 42-43.

Marginulina glabra, Bartenstein and Brand, 1937, p. 160, pl. 10, fig. 25a-b; pl. 11b, fig. 11; pl. 13, fig. 16a-b.

Specimens included here vary considerably in the height of the coil, and the shape of the cross-section. The chambers are less bulbous and the tests are slimmer than in Terquem's figures, but are otherwise identical.

This species is very similar to *Marginulina glabra* d'Orbigny, which is a Recent form, and perhaps identical.

Genus DENTALINA d'Orbigny, 1826

DENTALINA BICORNIS Terquem

Plate 4, figure 7

Dentalina bicornis Terquem, 1870b (pars), p. 370, pl. 29, figs. 13-16 (*non* fig. 17).

Dentalina bicornis, Bartenstein and Brand, 1937, p. 138, pl. 10, fig. 17a-c; pl. 15a, fig. 8.

Dentalina bicornis, Seibold and Seibold, 1953, p. 59, pl. 4, fig. 15; pl. 5, fig. 17.

This species is rare, and was observed only in the Kemble Beds at Oxfordshire.

DENTALINA COMMUNIS d'Orbigny

Plate 4, figure 11

Dentalina communis d'Orbigny, 1826, p. 254, no. 35.

Dentalina pseudocommunis Franke, 1936, p. 30, pl. 2, fig. 20a-b.

Dentalina ventricosa Franke, 1936, p. 33, pl. 3, fig. 1a-b.

Dentalina communis, Bartenstein and Brand, 1937, p. 136, pl. 1a, fig. 6; pl. 1b, figs. 14-15; pl. 2a, fig. 5; pl. 2b, figs. 9-10; pl. 3, fig. 8; pl. 4, fig. 23a-b; pl. 5, fig. 13; pl. 6, fig. 10.

Dentalina ventricosa, Bartenstein and Brand, 1937, p. 140, pl. 4, fig. 20; pl. 5, fig. 15.

Dentalina communis, Macfadyen, 1941, p. 39, pl. 2, fig. 34.

Dentalina pseudocommunis, Barnard, 1950b, p. 19, pl. 3, figs. 6, 7.

This species was originally described from Recent sediments of the Mediterranean, and there is much disagreement about the systematic position of the Jurassic forms. Macfadyen studied Recent forms from the Mediterranean and concluded that those from the Jurassic are identical. Barnard found the Jurassic forms to be highly variable, and referred his specimens to *D. pseudocommunis* Franke, as he felt it unlikely that such a variable species could have such a long range in time. Brotzen (1953, p. 35) does not believe that the Jurassic forms are closely related to the modern ones, suggesting that they may not even belong to the genus *Dentalina.* I agree with Macfadyen, and can see no morphological distinction between the Recent and the Jurassic forms. It is possible that *D. communis* is a morphological type of polyphyletic origin occurring in Mesozoic and Cenozoic strata, but the lineages have yet to be demonstrated.

Material deposited at M.C.Z. No. 3340B.

DENTALINA aff. D. COMMUNIS d'Orbigny

Plate 4, figures 14-15

Test small, arched, oval in cross-section, with four to six chambers, higher than wide, increasing in size as added, early ones irregular in shape, last ones much larger than preceding and bulbous; sutures depressed, only slightly oblique; proloculus small, spherical; aperture central, radiate.

These specimens are similar to *Dentalina communis* d'Orbigny but differ in their smaller size, less oblique sutures and more central position of the aperture. In addition, the early chambers are characterized by irregular growth, and the shape and size of these are very variable.

The relationships of this form are uncertain, and the resemblances with *D. communis* are probably superficial. The specimens recorded here appear to belong to a distinct species, but they are rare, occurring less than three to a sample, so that they cannot be adequately described.

The distribution is of some interest. Although specimens are rare they occur at a number of localities in the Upper Fuller's Earth Clay, Bradford Clay and Forest Marble on the Dorset Coast and the Bath area. They have not been recovered from lower horizons.

DENTALINA CONFERTA Schwager

Plate 4, figure 3

Dentalina conferta Schwager, 1865, p. 106, pl. 3, fig. 9.
Dentalina bullata Schwager, 1865, p. 107, pl. 3, fig. 23.
Dentalina brevis, Issler (*non* d'Orbigny), 1908, p. 63, pl. 3, figs. 150-154.
Dentalina linearis, Issler (*non* Roemer), 1908, p. 64, pl. 3, fig. 155.
Dentalina suboligostegia Franke, 1936, p. 25, pl. 2, fig. 1.
Dentalina numismalis Franke, 1936, p. 25, pl. 2, fig. 4.
Dentalina bullata, Seibold and Seibold, 1956, p. 128, pl. 7, fig. 3; text fig. 6a-b.
Dentalina conferta, Seibold and Seibold, 1956, p. 129, pl. 7, fig. 14; text fig. 5y.

This species is rare, and occurs only in the *Wattonensis* Beds at the Dorset Coast.

DENTALINA INTORTA Terquem

Plate 4, figures 16-19

Dentalina intorta Terquem, 1870b, p. 364, pl. 27, figs. 26-34.
Dentalina ventricosa, Bartenstein and Brand (*non* Franke), 1937, p. 140, pl. 4, fig. 20; pl. 5, fig. 15.
Dentalina lateralis, Bartenstein and Brand (*non* Terquem), 1937, p. 135, pl. 5, fig. 16a-b.

This species is highly variable in shape and size of the test. Most of the specimens are short and broad, but these grade into individuals that are long and slim. The proloculus varies in shape from globular, equidimensional types to long, narrow ones. In all specimens observed the proloculus is large, and no microspheres were recognized. The later chambers tend to become bulbous and overlap the preceding ones on the convex side. In some specimens the axis of the last chambers tends to rotate from the axis of the preceding ones, sometimes as much as ninety degrees. This results in a plan of growth that is similar to species included with the Polymorphinidae.

These specimens are identical with those figured by Terquem and the specimens in the Terquem collection in Paris. One of the specimens in the collection shows a shift on the axis of the last chamber from the preceding ones, such as has been described above.

This species is common in the English Bathonian. In northwest Germany, identical forms described by Bartenstein and Brand are recorded from the Lias.

DENTALINA MUCRONATA Neugeboren

Plate 4, figures 1-2; text-figure 4

Dentalina mucronata Neugeboren, 1856, *in* Ellis and Messina, *Catalogue of Foraminifera.*

Dentalina cornuformis Terquem, 1870b, p. 367, pl. 28, fig. 16.

Dentalina turgida, Wisniowski (*non* Schwager), 1890, p. 201, pl. 1, fig. 48.

Dentalina mucronata, Bartenstein and Brand, 1937, p. 138, pl. 10, fig. 16; pl. 11b, fig. 5a-b; pl. 12b, fig. 4a-b.

The shape of the test is highly variable. Most individuals are moderately broad, but some are long and slender while others are stout. Some of the broad forms are slightly arched at the base and have low, broad proloculi. Such specimens are morphologically indistinguishable from *Vaginulina legumen* (Linné), and can be identified only by their association with transitional and more typical forms in a single assemblage. The variation and resemblance of "end forms" to *Vaginulina legumen* is illustrated in Figure 4.

A similar form is *Dentalina communis* d'Orbigny, but in this latter species the margins are smooth and the chambers are not inflated.

This species was originally described from the Tertiary of the Vienna Basin. The Bathonian forms compare well with Neugeboren's figures, but specimens from the Tertiary were not examined. Specimens of *Dentalina cornuformis* from the Terquem collection in Paris are identical with those recorded here.

This species is fairly common in the English Bathonian, particularly in the Upper Fuller's Earth Clay of the Dorset Coast.

Material deposited at M.C.Z. Nos. 3344C, 3344D.

DENTALINA NODIGERA Terquem and Berthelin
Plate 4, figure 8

Dentalina nodigera Terquem and Berthelin, 1875 (pars), p. 25, pl. 1, fig. 31a only.

Dentalina nodigera, Franke, 1936, p. 26, pl. 2, fig. 7a-b.

Specimens are rare, and consist only of fragments. The tests are thin, transparent and composed of pyriform chambers which are inflated on one side and compressed on the other. The sutures are depressed and the last chambers have rather long necks with bulbous accumulations of calcite on the ends. The apertures are somewhat indistinct, but appear to be rounded.

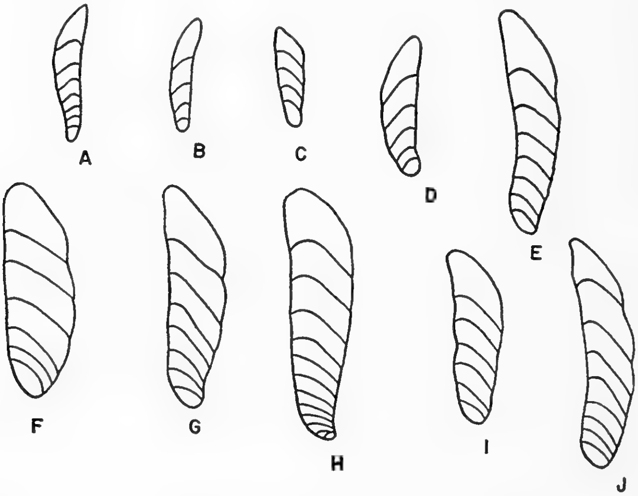

Figure 4. Variation of *Dentalina mucronata* (Neugeboren) and *Vaginulina legumen* (Linné), showing similarity of end forms in the two species.

DENTALINA OOLITHICA Terquem
Plate 4, figure 10

Dentalina oolithica Terquem, 1870b, (pars), p. 366, pl. 28, figs. 5-6 only.

Dentalina plebeia Terquem 1870b (pars), p. 369, pl. 29, figs. 3-6 only.

Terquem included a variety of forms in this species. The present specimens agree well with those in the Terquem collection and with the illustrations cited above. The remaining figures are possibly illustrations of variants of other species, but the drawings appear schematic and unlike anything I have encountered in the English Bathonian.

This species occurs throughout the English Bathonian, and is particularly common in the Upper Fuller's Earth Clay.

DENTALINA PROPINQUA Terquem

Plate 4, figures 4-6

non Dentalina jurensis Gumbel, 1862, p. 220, pl. 3, figs. 14a-c.

Dentalina jurensis Terquem, 1870b, p. 362, pl. 27, figs. 6-16.

Dentalina propinqua Terquem, 1870b, p. 365, pl. 28, figs. 1-2.

Dentalina sinemuriensis, Bartenstein and Brand (*non* Terquem), 1937, p. 139, pl. 1a, fig. 8; pl. 2b, fig. 12; pl. 4, fig. 21; pl. 5, fig. 19; pl. 6, fig. 12; pl. 8, fig. 11a-c.

Dentalina arbuscula, Bartenstein and Brand (*non* Terquem), 1937, p. 139, pl. 1a, fig. 7; pl. 2b, fig. 12; pl. 3, fig. 11; pl. 4, fig. 19; pl. 5, fig. 18.

non Dentalina jurensis, Seibold and Seibold, 1955, p. 112, pl. 13, fig. 9; text fig. 2n.

This species is intermediate in structure between *Dentalina* and *Nodosaria*. Most of the tests are arcuate, but some are straight and the sutures are transverse. There is much variation in the sutures, which are normally depressed, resulting in constriction of the chambers along the margins. Such forms, however, grade into those having perfectly flush sutures and smooth margins. The size of the aperture is also variable. Where there is little constriction of the final chamber it is large, but where the chamber is much constricted the aperture is narrow and typically dentaline. The aperture is only faintly radiate, and in some specimens may be rounded.

The name *Dentalina jurensis* by which Terquem designated this species was preoccupied by *D. jurensis* of Gumbel, as pointed out by Seibold and Seibold (1955, p. 113). However, *D. propinqua* appears to be identical with it, so that that name is used here to designate Terquem's species.

This species occurs throughout most of the Bathonian, but is most common in the Upper Fuller's Earth Clay.

DENTALINA SUBPLANA Terquem

Plate 4, figures 12-13

Dentalina subplana Terquem, 1870b (pars), p. 367, pl. 28, figs. 19, 20, 22 only.

Dentalina punguinculus, Bruckman (*non* Reuss), 1904, p. 28, pl. 3, figs. 29-31.

This species is similar to *Dentalina terquemi* d'Orbigny, and is probably closely related. It differs from the latter in the smaller size of the test, the more oblique sutures, and the lack of bulbous chambers in the last part of the test. *D. terquemi* appears to be restricted to the Lias in both England and northwest Germany. Forms comparable to *D. subplana* have not been recorded from northwest Germany. Another similar form is *D. vetustissima* d'Orbigny as described by Bartenstein and Brand (1937, p. 137, pl. 4, fig. 25; pl. 5, fig. 12). This latter species is more apiculate, and the chambers are less drum-like than in the present specimens. *D. vetustissima* was recorded from the Lias only, by Bartenstein and Brand.

The forms recorded here compare well with the figures cited, and with the specimens in the Terquem collection.

This species is common only in the *Wattonensis* Beds of the Dorset Coast, but also occurs in the Lower Fuller's Earth Clay of the Dorset Coast, the Fuller's Earth Rock, and the Bradford Clay of the Bath area.

DENTALINA TORTA Terquem

Plate 4, figure 9

Dentalina torta Terquem, 1858, p. 599, pl. 2, fig. 6a-b.

Dentalina torta, Franke, 1936, p. 27, pl. 2, fig. 9.

Dentalina torta, Bartenstein and Brand, 1937, pl. 3, fig. 9; pl. 4, fig. 24; pl. 5, fig. 14; pl. 10, fig. 11.

Dentalina varians, Bartenstein and Brand (*non* Terquem), 1937 (pars), p. 135, pl. 10, fig. 14; pl. 12b, fig. 3.

Dentalina ensis, Bartenstein and Brand (*non* Wisniowski), 1937, pl. 8, fig. 9a-b.

This species is similar to *Dentalina intorta* Terquem with which it may possibly intergrade. However, the tests of the specimens included here are larger and not as compressed as those of the latter species, but the sutures are more depressed, resulting in more bulbous chambers.

The English Bathonian forms differ somewhat from Terquem's figure, which illustrates a much more tapered test with less bulbous chambers and a proloculus which is much smaller than any observed in my material. The differences are minor, however, and these specimens are considered identical.

Genus NODOSARIA Lamarck, 1812

NODOSARIA CLAVULA (Terquem)

Plate 4, figure 20

Dentalina clavula Terquem, 1870b, p. 366, pl. 28, fig. 4.

These specimens compare well with Terquem's figure, except that they do not show the depressed sutures, indicated in Terquem's figure.

This species is very rare, and was discovered only from the Forest Marble on the Dorset Coast.

NODOSARIA HORTENSIS Terquem

Plate 4, figures 22-24

Nodosaria hortensis Terquem 1866b, p. 476, pl. 19, fig. 13.
Nodosaria fontinensis Terquem 1870b, p. 353, pl. 26, figs. 1-5.
Nodosaria variablis Terquem 1870b, p. 353, pl. 26, figs. 6-12.
Nodosaria mutablis Terquem and Berthelin 1875, p. 20, pl. 1, fig. 19a-b.
Nodosaria hortensis, Macfadyen, 1941, p. 43, pl. 3, fig. 41a-b.
Nodosaria hortensis, Barnard, 1950b, p. 19, pl. 3, fig. 3.

An exhaustive synonymy of this species has been provided by Macfadyen (1941, p. 43). In their remarks on *Nodosaria fontinensis* (a synonym) Bartenstein and Brand (1937, p. 148) noted that the Dogger specimens tend to have finer, less sharp costae than those from the Lias. A comparison of the present material with that of the Lias of Byfield described by Barnard reveals similar differences.

NODOSARIA INGENS (Terquem)

Plate 4, figure 25

Dentalina ingens Terquem 1870b, p. 361, pl. 27, fig. 5.
Nodosaria guttifera, Bartenstein and Brand (*non* d'Orbigny), 1937, p. 144, pl. 13, fig. 7.

The material consists of a few fragments composed of two or three bulbous chambers connected by long necks. The apertures are radiate.

A similar species is *Dentalina guttifera* d'Orbigny, which is a Tertiary form, originally described from the Vienna Basin. In the present species, however, the chambers are more inflated and tapered less towards the apertural neck.

NODOSARIA aff. N. ISSLERI Franke

Plate 4, figures 36-37

Test small, slightly tapered, composed of four to six chambers increasing in height and breadth as added; sutures depressed, transverse; growth somewhat irregular in early stages, resulting sometimes in slightly arched test; last chamber considerably larger than preceding and flaring; surface ornamented with ten fine ribs extending continuously from base of proloculus to end of last chamber; proloculus small, rounded; aperture terminal, rounded, situated on a short neck.

The English Bathonian forms are similar to *Nodosaria issleri* Franke, and differ only in the greater persistence of the ribs which extend up to the end of the apertural neck. Paratypes of *Nodosaria issleri* were examined at the Senckenberg Museum, Frankfurt a.M., and the present specimens are undoubtedly closely related to this species. Another similar and probably related form is that figured by Issler (1908, p. 52, figs. 73-78) as *Nodosaria raphanus* (Linné) which lacks the apertural neck, but is otherwise indistinguishable.

NODOSARIA LIASSICA Barnard

Plate 4, figure 33

Nodosaria obscura, Bartenstein and Brand (*non* Reuss), 1937, p. 147, pl. 8, fig. 18.

Nodosaria obscura var. *liassica* Barnard, 1950b, p. 18, text fig. 10.

A few specimens are identical with those described by Barnard from the Upper Lias of Byfield. The Jurassic forms are treated here as a separate species, since Reuss's figure of *N. obscura* is not clear and the relationship with the Cretaceous form is uncertain.

This species is rare, and was observed only in the Lower Fuller's Earth Clay of the Dorset Coast.

NODOSARIA OPALINI Bartenstein

Plate 4, figures 26-31

Nodosaria opalini Bartenstein and Brand, 1937, p. 147, pl. 8, fig. 13a-b; pl. 10, fig. 18a-b.

This species exhibits much variation in the amount of sutural depression and in the strength of the costae. In many specimens the sutures are flush, and the chambers show no constriction. In others, the sutures in the later portion of the test are depressed, and the last chambers are constricted. Some specimens have constricted chambers throughout the length of the test. Costae vary from strong, well defined ribs, to faint, barely perceptible striations. They are, however, always present and are numerous.

This species is widely distributed throughout the English Bathonian, and is particularly common in the Upper Fuller's Earth Clay. There are no previous records of it in England. In Germany it has been recorded from the Dogger Alpha (Lower Bajocian) by Bartenstein and Brand.

NODOSARIA PECTINATA (Terquem)

Plate 4, figures 34-35

Dentalina pectinata Terquem, 1870b, p. 360, pl. 26, figs. 26-30.

The material consists of fragments composed of three or four chambers. Although the tests are distinctly arched, the transverse sutures and centrally located apertures suggest that the specimens are better placed in *Nodosaria* than *Dentalina*.

The specimens have been compared with those in the Terquem collection and are identical.

NODOSARIA PLICATILIS Wisniowski

Plate 4, figure 21

Nodosaria plicatilis Wisniowski, 1890, p. 194, pl. 1, fig. 16.
Nodosaria plicatilis, Paalzow, 1922, p. 16, pl. 2, fig. 4.
Nodosaria plicatilis, Bartenstein and Brand, 1937, p. 149, pl. 15a, fig. 14.

This species resembles *N. hortensis* in its ornamentation and in its general shape. The two species often occur together, but *N. plicatilis* is distinguished by being more oval in cross-section, with fewer costae.

NODOSARIA aff. N. PRIMA d'Orbigny

Plate 4, figure 32

Test straight or slightly arched, tapered; chambers numerous, generally seven or eight composing the test, increasing in size as added, but occasional chamber smaller than previous, longer than broad, only slightly inflated; proloculus large, spherical; surface covered with about fourteen prominent costae extending continuously from tip of proloculus to tip of aperture; aperture terminal, radiate, generally centrally located, but sometimes shifted towards margin; sutures transverse or very slightly oblique, depressed.

The shift of the aperture from the center to the margin in some specimens, as well as the occasional curvature of the test is reminiscent of *Dentalina*, and this form is somewhat intermediate in structure.

These specimens are similar to the types of *N. prima* as refigured by Macfadyen, but these illustrations do not show the curvature of the test or the shift of the aperture towards the margin. This species resembles *N. hortensis*, but has a radiate aperture in addition to more numerous and persistent costae.

NODOSARIA sp. A

Plate 4, figure 38

The material consists of a single, tiny specimen which is very slender and is composed of three chambers. The sutures are flush, so that the outline of the test is smooth. The chambers are almost twice as high as broad, with the center one being the longest. There is no visible ornamentation and the aperture is central and radiate.

The specimen resembles *N. pyriformis* Terquem figured by Macfadyen (1941, p. 46, pl. 3, fig. 44), but the chambers are not as pyriform. It is also similar to *N. pyrula* d'Orbigny as figured by Haeusler (1890, p. 28, pl. 5, figs. 25-26), but is a much slimmer test and has fewer chambers. The single specimen occurs in the Sharp's Hill Beds, Oxfordshire.

NODOSARIA sp. B

Plate 4, figure 39

The material consists of several fragments composed of four or five chambers arranged in a straight series, with the first chambers broader than long, and the later ones longer than broad. The surface is covered with numerous, fine costae which are barely perceptible. The sutures are transverse, with the earlier chambers impressed on the later ones. The aperture is central and rounded.

These specimens are similar to *N. pectinata* (Terquem), but are much smaller, and have much fainter costae. The impressed sutures have not been observed on *N. pectinata*.

Genus TRISTIX Macfadyen, 1941

TRISTIX SUPRAJURASSICUM (Paalzow)

Plate 5, figure 12

Rhabdogonium suprajurassicum Paalzow, 1932, p. 125, pl. 9, fig. 7.

Triplasia somaliensis Macfadyen, 1935, p. 11, pl. 1, fig. 7a-b.

Trifarina bradyi, Bartenstein and Brand (*non* Cushman), 1937, p. 185, pl. 15b, fig. 1a-b.

Trifarina oolithica, Bartenstein and Brand (*non* Terquem), 1937, p. 186, pl. 11b, fig. 26; pl. 15b, fig. 2a-c.

Tristix triangularis Barnard, 1953, p. 190, text-fig. A5.

The aperture is finely but distinctly radiate. The proloculus is large and spherical and no microspheres have been recognized. In most specimens there are distinct crenulated keels on the three borders which extend into the prolocular area. In one test the borders are rounded and there are no keels, suggesting synonymy with *Tristix liasina* (Terquem and Berthelin). However, specimens are rare and relationships between the two species cannot be demonstrated from the present material.

Genus PSEUDONODOSARIA Boomgart, 1949

PSEUDONODOSARIA VULGATA (Borneman)

Plate 5, figure 3

Glandulina vulgata Borneman, 1854, p. 31, pl. 2, figs. 1a-b, 2.
Glandulina tenuis Borneman, 1854, p. 31, pl. 2, fig. 2a-b.
Pseudoglandulina vulgata, Bartenstein and Brand, 1937, p. 150, pl. 4, fig. 41; pl. 6, fig. 16; pl. 8, fig. 19; pl. 15a, fig. 15.

Specimens are rare, but appear to fall well within the range of variation of this highly variable species. The chambers are more bulbous and constricted at the sutures than is shown on Borneman's figures. The specimens most closely resemble the figures of Bartenstein and Brand.

PSEUDONODOSARIA HYBRIDA (Terquem and Berthelin)

Plate 5, figures 7-11

Glandulina hybrida Terquem and Berthelin, 1875, p. 22, pl. 1, fig. 26.
Pseudoglandulina irregularis, Bartenstein and Brand (*non* Franke), 1937, (pars), p. 151, pl. 8, fig. 21 only.

Test long, slender, straight or slightly arcuate, apiculate, rounded or suboval in cross-section; chambers numerous, varying in number from four to ten, generally greater in height than breadth, but highly irregular in early portion with some chambers very low, greatest increase in height after second chamber; sutures depressed or flush, varying considerably in single specimens; proloculus rounded, tiny; aperture terminal, large, rounded or slightly radiate.

The variational pattern of this species is similar to that of *Pseudonodosaria vulgata* (Borneman) as described by Barnard (1950b, p. 24) from the Lias of Byfield, and most of the chambers are highly irregular in size and shape. The two species are similar, but *P. hybrida,* which is the more common one in the English Bathonian, is distinguished by the more slender test and the blunter, less bullet-like shape of the last chamber. The shape of the last chamber is remarkably constant, even though the earlier ones are highly variable.

This species is common in the Cotswold area of the English Bathonian.

Material deposited at M.C.Z. No. 3362D.

PSEUDONODOSARIA OVIFORMIS (Terquem)

Plate 5, figures 1-2

Glandulina oviformis Terquem, 1864a, p. 168, pl. 7, fig. 4a-b.
Nodosaria humilis, Jones and Parker (*non* Roemer), 1860, pl. 19, fig. 6.
Nodosaria glans, Jones and Parker (*non* d'Orbigny), 1860, pl. 19, fig. 7.
Pseudoglandulina oviformis, Bartenstein and Brand, 1937, p. 149, pl. 4, fig. 40.
Pseudoglandulina oviformis, Macfadyen, 1941, p. 47, pl. 3, fig. 47.
Pseudoglandulina oviformis, Barnard, 1950b, p. 24, pl. 1, fig. 6.

The specimens agree well with Terquem's figures, except that the outline of the test is perfectly smooth, and there is no constriction of the chambers at the sutures. In addition, the apertures are distinctly radiate, which is not indicated in the figure. The minute size, smooth surface and slightly fusiform shape distinguish the species. This species is characteristic of the Lower Jurassic, and has been recorded from numerous localities. In the English Bathonian it was observed only in the Lower Fuller's Earth Clay on the Dorset Coast, where the material consists of three specimens.

PSEUDONODOSARIA PUPOIDES (Borneman)

Plate 5, figures 4-6

Orthocerina pupoides Borneman, 1854, p. 35, pl. 3, fig. 16a-b.
Pseudoglandulina pupoides, Bartenstein and Brand, 1937, p. 150, pl. 5, fig. 30; pl. 8, fig. 20.

This species resembles *P. oviformis,* but is a larger, heavier form and is not as fusiform. Occasional specimens, however, are small and have thin, transparent walls.

This species occurs throughout most of the English Bathonian, but is common only in the Upper Fuller's Earth. Most of the specimens are poorly preserved, and more adequate material may reveal the present specimens to be variants of some other species of *Pseudonodosaria.*

Genus VAGINULINA d'Orbigny, 1826

VAGINULINA CLATHRATA (Terquem)

Plate 5, figures 20-22

Marginulina longuemari var. *clathrata* Terquem, 1864a, p. 192, pl. 8, figs. 16, 19a-b.

Frondicularia fenestrata Terquem, 1886, p. 43, pl. 4, fig. 35.
Vaginulina proxima, Franke (*non* Terquem), 1936, p. 85, pl. 8, fig. 34.
Vaginulina proxima, Bartenstein and Brand, 1937, p. 164 (pars), pl. 6, fig. 23 only.
Vaginulina clathrata, Barnard, 1950b, p. 29, pl. 1, figs. 8-10.

Material of this species from the Lias of Byfield has recently been described in great detail by Barnard (1950b). It is highly variable, particularly in the ornamentation and curvature of the test. Barnard illustrated three forms, in one of which the test is absolutely straight and in the other two the early portions are strongly curved. He interpreted the differences as being indicative of dimorphism, and designated the straight type as the megalosphere and the other two as the microspheres. However, there are no appreciable size differences among the proloculi of the three forms. If anything, the proloculi of the two curved types are slightly larger than that of the straight one. Furthermore, examination of Barnard's material reveals that all three types are linked by transitional forms. Consequently, there is no clear indication of dimorphism, although the forms figured by Barnard nicely illustrate the more important variational aspects of the species.

The specimens from the Bathonian are identical with the forms described by Barnard and show the same variational patterns, although they are considerably less abundant than in the Lias. They are also identical with one of the forms of *V. proxima* (Terquem) described by Bartenstein and Brand, but the variability of those specimens is not known.

Payard (1947) dealt with this and similar species described by Terquem, and having access to the Terquem collection erected five new species and two varieties. All of them appear to be individual variants of a single species.

This species (*sensu stricto*) occurs in the basal beds of the Lower Fuller's Earth Clay, and has not been observed in younger strata.

VAGINULINA CLATHRATA EYPENSA n. subsp.

Plate 5, figures 23-26

Vaginulina proxima, Bartenstein and Brand (*non* Terquem), 1937, p. 164 (pars), pl. 8, fig. 27a-b; pl. 11b, fig. 13; pl. 14b, fig. 6a-b.

Test large, stout, broad in relation to height, straight or slightly curved; chambers numerous, about five to seven composing the test, increasing rapidly in breadth as added, only slightly so in height; sutures straight or slightly curved, depressed; surface covered by numerous strong costae, extending over greater portion of test; proloculus in megalosphere large, globular; aperture at peripheral margin, radiate.

Only one microsphere was observed, and it differed from the megalospheres only in the smaller size of the proloculus; there is no difference in the curvature of the early portion of the test. There is much modification in the development of the ribs, and although they are always strong, they are not always persistent. Some specimens are very broad, and on these the ribs tend to be less well developed away from the central portion of the test.

This subspecies differs from the forms of *V. clathrata* from the Lias, described by Barnard (see above), in being broader and in having a more irregular development of the ribs. There is much overlap between the two forms and they differ only in their patterns of variation; the subspecies lacks the slim, elongate types.

This subspecies is common in the Fuller's Earth Rock and the *Wattonensis* Beds, and was not observed in older rocks; consequently it stratigraphically succeeds *V. clathrata* (*sensu stricto*). The illustrations of Bartenstein and Brand suggest that *V. proxima* consists of two comparable forms which also occur in chronologic succession; the long straight form referable to *V. clathrata* (*sensu stricto*) occurs in the Lias Zeta while the broader forms referable to *V. clathrata cypensa* are first shown to occur in the Dogger Alpha.

Material deposited at M.C.Z. No. 3366D.

VAGINULINA CONTRACTA (Terquem)

Plate 5, figure 17

Marginulina contracta Terquem, 1868, p. 125, pl. 8, figs. 13-24.

Marginulina contracta, Terquem, 1886, p. 25, pl. 2, figs. 44-54.

Vaginulina contracta, Bartenstein and Brand, 1937, p. 162, pl. 12b, fig. 8; pl. 15a, fig. 23a-b; pl. 15c, fig. 11a-b.

This species is similar to *Vaginulina legumen* (Linné), but is flatter, smaller, and generally has fewer chambers. Occasional specimens have last chambers overlapping on the oral margin and are chevron shaped.

This species is common throughout the Bathonian.

VAGINULINA HARPA Roemer

Plate 5, figures 18-19

Vaginulina harpa Roemer, 1841, p. 96, (pars), pl. 15, fig. 12 only.
Vaginulina harpa, Haeusler, 1890, p. 108, pl. 15, figs. 22, 23, 27.
Vaginulina harpa, Macfadyen, 1935, p. 12, pl. 1, fig. 8a-b.
Vaginulina harpa, Bartenstein and Brand, 1937, p. 163, pl. 14b, fig. 7; pl. 14c, fig. 10; pl. 15a, fig. 24a-b; pl. 15c, fig. 12a-d.

The present specimens agree well with the figures cited, and are identical with the specimens illustrated by Bartenstein and Brand.

The species is rare, occurring only in the Lower Fuller's Earth Clay and the *Wattonensis* Beds on the Dorset Coast.

VAGINULINA cf. V. HECHTI Bartenstein

Plate 5, figure 14

A single, broken specimen recovered from the *Wattonensis* Beds on the Dorset Coast consists of the first three chambers of the test. There are three oblique ribs on the proloculus. The proloculus is larger than that described by Bartenstein and Brand (1937, p. 165, pl. 8, fig. 21a-b), but otherwise compares favorably.

VAGINULINA LEGUMEN (Linné)

Plate 5, figures 15-16

Vaginulina legumen Blake, 1876, p. 464, pl. 19, fig. 11.
Vaginulina legumen Haeusler, 1890, p. 107, pl. 14, fig. 49.
Vaginulina legumen Paalzow, 1917, p. 237, pl. 45, figs. 10-11.
Vaginulina legumen Bartenstein and Brand, 1937, p. 162, pl. 15a, fig. 22.

The present specimens exhibit much variation, particularly in the breadth of the test and in the shape of the proloculus. In some variants the test is slim, and there is no curvature in the early portion, so that they are structurally identical with *Dentalina.* These variants are morphologically indistinguishable from *Dentalina mucronata* (Neugeboren), and can be separated from it only by their association with transient and more typical forms. The similarity of the "end forms" of the two species is illustrated in Figure 4A-J.

There are many records of this species from the Jurassic, although the type is a Recent form from the Mediterranean. The figure of the type in the Ellis and Messina *Catalogue of Foraminifera* reveals a large, heavy form which is distinctly keeled and has limbate sutures. Some variant forms in the Jurassic are comparable, but most of them are smaller with depressed sutures and lack keels. The relationships are uncertain and the Jurassic forms should probably be referred to a separate species.

Material deposited at M.C.Z. No. 3370B.

VAGINULINA MACILENTA (Terquem)
Plate 5, figure 13

Marginulina macilenta Terquem, 1869, p. 12, pl. 7, figs. 1-18.

Vaginulina macilenta, Bartenstein and Brand, 1937, p. 163, pl. 11b, fig. 12a-b.

The present specimens are identical with those in the Bartenstein and Brand collection at the Senckenberg museum, Frankfurt a.M. These authors record this species from the Dogger Alpha through Delta in northwest Germany. In the present material it was observed only in the Lower Fuller's Earth Clay, where it is very rare.

VAGINULINA sp. A.

Test small, curved, oval in cross-section, only slightly compressed, rounded on periphery; chambers varying in number from four to six, increasing in breadth as added, only slightly in height, last one very large compared to previous; sutures straight, thin, flush; proloculus round; aperture radiate.

These specimens, which occur sporadically throughout the Bathonian, are probably variants or immature forms of some species such as *Vaginulina legumen* or *V. contracta,* with which they often occur.

Material deposited at M.C.Z. No. 3372.

Genus CITHARINA d'Orbigny, 1839

CITHARINA COLLIEZI (Terquem)

Plate 6, figures 1-2

Marginulina colliezi Terquem, 1866a, p. 430, pl. 17, figs. 10a-c.
Marginulina flabelloides Terquem, 1868, p. 102, pl. 6, figs. 1-30.
Vaginulina strigillata, Jones and Parker (*non* Reuss), 1860, p. 457, pl. 20, figs. 30-35.
Vaginulina cf. *V. flabelloides*, Deeke, 1884, p. 29, pl. 1, fig. 16.
Vaginulina flabelloides, Franke, 1936, p. 87, pl. 8, figs. 43, 44a-b.
Vaginulina flabelloides, Bartenstein and Brand, 1937, p. 164, pl. 6, fig. 27; pl. 8, fig. 30a-c; pl. 19, fig. 27; pl. 12b, fig. 9; pl. 14b, fig. 8 only.
Citharina colliezi, Barnard, 1950b, p. 14, pl. 3, fig. 1.

This species is represented by few individuals and is a distinctive form in the English Bathonian. However, in other regions where it occurs in abundance it is highly variable and is not easily distinguished from other species, notably *Citharina harpula* and *C. heteropleura*. This is particularly true at Fontoy (Moselle), where Terquem originally described these and other comparable species. The specimens in the Terquem collection include many that are transitional between very unlike types. Highly variable are the strength and number of ribs, and the outline of the test. The ribs range from fine striations typical of the species to heavy costae characteristic of the *Vaginulina proxima* and *V. inconstans* group. The shape of the tests varies from fanlike, as in *Citharina heteropleura,* to slim, narrow types as is found in *Vaginulina clathrata.* It is not known which if any of these specimens are the types, nor are the exact horizons at which the specimens occur known, so that the relationships of this complex group can not be ascertained until the type locality has been carefully recollected and topotypes have been examined.

The present specimens have been compared with those described by Barnard from the Lias, and are identical. The species is not common in the Bathonian, and perhaps for this reason exhibits little variation. It occurs in the Lower Fuller's Earth Clay and *Wattonensis* Beds of the Dorset Coast and the Bath areas, but was not observed at younger horizons.

CITHARINA HETEROPLEURA (Terquem)

Plate 6, figures 4-5

Marginulina heteropleura Terquem, 1868, p. 116, pl. 7, figs. 19-25.
Marginulina pinguis Terquem, 1868, p. 119, pl. 7, figs. 28-29.

Marginulina distensa Terquem, 1868, p. 120, pl. 7, fig. 30.
Marginulina flabelloides, Bartenstein and Brand (*non* Terquem), 1937, p. 164 (pars), pl. 14c, fig. 11; pl. 15a, fig. 25a-b.

This species is similar to *Citharina colliezi* but differs from it in the broader, more fan-shaped test. The sutures are depressed, resulting in chambers that are slightly bulbous. The ribbing is very fine, but is persistent and crosses the sutures. There is no morphologic overlap of the two species in the present material but the morphologic affinities appear to be close and perhaps they represent two stratigraphic subspecies. *C. heteropleura* was recovered only from the Upper Fuller's Earth Clay, while *C. colliezi* was not observed above the Fuller's Earth Rock. In northwest Germany Bartenstein and Brand have included both of these species in *Vaginulina flabelloides*. From examination of their figures, which are arranged stratigraphically, forms comparable to *Citharina colliezi* occur in the Lias, and the others comparable to *C. heteropleura* occur in the Dogger.

CITHARINA sp.

Plate 6, figure 3

Test large, thick, highly compressed, subtriangular in side view; chambers numbering eight, increasing rapidly in breadth as added, only slightly in height; sutures flush, mostly obscured by thirteen fine costae covering the surface, extending from proloculus to end of last chamber; proloculus small, subelliptical; aperture radiate, on a short neck formed by junction of margins.

The material consists of a single specimen recovered from the *Wattonensis* Beds on the Dorset Coast. The costae and plan of growth are similar to *Vaginulina harpa*, but the angular outline and thickness are distinctive.

Genus LINGULINA d'Orbigny, 1826

LINGULINA DENTALINIFORMIS Terquem

Plate 6, figures 11-12

Lingulina dentaliniformis Terquem, 1870b, p. 339, pl. 25, figs. 1-3.
Lingulina dentaliniformis, Terquem, 1886, p. 12, figs. 27-29.
Lingulina dentaliniformis, Bartenstein and Brand, 1937, p. 152, pl. 10, fig. 20.

The test is smooth, but occasional specimens reveal faint striations when viewed under high power. This species is very similar to *Frondicularia dentaliniformis* and can be distinguished from it only by the sutures, which are transverse or slightly arched. The convexity of the sutures is variable, however, and some specimens are difficult to identify.

This species is rare in the English Bathonian.

LINGULINA DOLIUM (Terquem)

Plate 6, figures 9-10

Frondicularia dolium Terquem, 1870b, p. 338, pl. 23, figs. 9-12.
non Lingulina dolium Terquem, 1870b, p. 340, pl. 25, figs. 4-5.

Test smooth, compressed, initial end conical, remainder rectangular; chambers varying in number from four to ten, increasing rapidly in height after second or third chamber, then increasing gradually as added, with no increase in breadth; sutures slightly depressed, generally tranverse, but often with sinuous pattern; proloculus minute, globular; aperture elongate, slit-like.

Terquem's figure shows a projected initial end, with the proloculus and succeeding chamber combined, so that the minute proloculus is not apparent. This is probably an inaccuracy in the drawing, as the specimen in the Terquem collection clearly has a tiny proloculus, identical with those in the present specimens. The sutures of the specimens in the collection are decidedly more sinuous than shown in Terquem's figure.

A similar form is *Lingulina ovalis* Schwager (*non* Terquem and Berthelin) described from the Lower Oxfordian of Germany. This species exhibits the same sinuous sutural pattern, but the proloculus is much larger, and the chambers are more constricted at the sutures.

LINGULINA LAEVISSIMA (Terquem)

Plate 6, figures 6-8

Frondicularia laevissima Terquem, 1866b, p. 481, pl. 19, fig. 19.
Lingulina laevissima, Franke, 1936, p. 62, pl. 6, fig. 11.
Lingulina taenoides Franke, 1936, p. 62, pl. 6, fig. 12.

The original description of this species by Terquem is as follows (translated from the French): "Test elongate, compressed, straight, smooth, obtuse at both ends, periphery rounded, composed of eight transverse chambers, the first ones plane, quadrangular, the last two a little extended, arched in the middle, aperture oval."

In these specimens the last chambers are not inflated, and there is only the slightest trace of arched sutures. In all cases the apertures are indistinct, and it can not be determined if they are radiate or rounded. They agreee best with *Lingulina taenoides* Franke, which I believe is a synonym of *L. laevissima.*

There is much divergence of opinion concerning this species, and a variety of forms have been included under this name. Macfadyen (1941, p. 50, pl. 3, fig. 51a-b), for example, has ignored Franke's *L. laevissima,* and has, instead, included Franke's *L. lanceolata* as a synonym. This is a very slim form with highly arched sutures. Barnard (1956, p. 272) regards Franke's *L. laevissima* and *L. lanceolata* as one species. In my opinion none of these forms agree as well with the figure of the type as do those figured by Franke.

This species occurs commonly in the Bathonian, but individuals are not common. Specimens are generally squashed and poorly preserved.

LINGULINA sp. A

Plate 6, figure 15

Test elongate, slightly rounded in cross-section; chambers numbering eight, first five minute, then increasing rapidly in width, producing spiked appearance to lower portion of test, last chamber elongate, bullet shaped; sutures slightly depressed, indistinct, slightly arched; aperture rounded.

The arched sutures resemble *Frondicularia,* but are not truly "V"-shaped. The apiculate initial end, composed of four minute chambers, distinguishes this form from any other encountered, though possibly it may be a variant of one of the smooth *Lingulina* species or even of one of *Frondicularia.*

This form is rare and was observed only in the Cotswolds.

LINGULINA sp. B

Plate 6, figure 14

Test highly perforate, compressed, elongate, oval in cross-section; chambers numbering three, last one about equal in length to other two combined; aperture central radiate.

The highly perforate test and very long third chamber are very distinctive, and the test is unlike that of any other form encountered.

The material consists of one specimen, which was recovered from the Wychwood Beds, in the Kirtlington Cement Works, Oxfordshire.

LINGULINA sp. C

Plate 6, figure 16

Test compressed, smooth, triangular, slightly twisted; chambers numbering six or seven, increasing in size as added, broader than high, but growth somewhat irregular, constricted at the margins; sutures slightly convex, mostly concentric, but with sinuous pattern in last two chambers; proloculus tiny, rounded; aperture central, indistinct in all specimens, but apparently rounded.

This form bears some resemblance to *Lingulina dentaliniformis* but is much broader, and exhibits a sinuous sutural pattern in the later chambers. The wall is heavier, and the surface appears to be rugose, although this may be due to the state of preservation.

Specimens are rare, and were observed only in the Cotswolds.

Genus FRONDICULARIA Defrance, 1824

FRONDICULARIA DENTALINIFORMIS Terquem

Plate 6, figures 17-19

Frondicularia dentaliniformis Terquem, 1870b, p. 319, pl. 23, figs. 1-8.

Frondicularis dentaliniformis, Bartenstein and Brand, 1937, p. 153, pl. 10, fig. 22.

All of the specimens are characterized by the constricted chambers, and the markedly depressed, convex sutures. The aperture is variable, but the radiate form appears to be the exception. The distribution of the species is sporadic, and specimens per sample are few, so that the variation could not be observed in single populations, and the description here is based on isolated specimens from various localities and horizons.

This species resembles, and undoubtedly is closely related to, *Frondicularia nodosaria* and *Lingulina dentaliniformis*. It differs from the former in the lack of clear-cut costae, the greater constriction of the chambers and in the more deeply depressed sutures. It can be distinguished from the latter by the greater convexity of the sutures. It is possible that all three species are transitional, as is suggested by Bartenstein and Brand (1937, p. 109); however, the relationships are not apparent on the basis of the present rather sparsely distributed material.

FRONDICULARIA INVOLUTA Terquem

Plate 7, figures 1-3

Frondicularia involuta Terquem, 1866a (pars), p. 403, pl. 15, fig. 3a-b only.
Frondicularia complanata, Jones and Parker (*non* Defrance), 1860, p. 457, pl. 1, fig. 19.
Frondicularia oolithica Terquem, 1870b, p. 315 (pars), pl. 22, figs. 1-6.
Frondicularia complanata, Blake, 1876, p. 468, pl. 19, fig. 20.
Frondicularia lignaria, Bartenstein and Brand (*non* Terquem), 1937, p. 152, pl. 8, fig. 25a-b; pl. 10, fig. 21; pl. 11a, fig. 7; pl. 11b, fig. 8; pl. 12a, fig. 5; pl. 12b, fig. 7; pl. 13, fig. 11; pl. 14, fig. 6.
Frondicularia involuta, Barnard, 1950b, p. 13, pl. 2, figs. 8-9.

In the Bathonian this species exhibits little variation, and the specimens are consistently broad. Barnard noted the same situation in the Lias. The present specimens agree well with those described from the Lias by Barnard, except that the Bathonian ones are more robust and the chambers are slightly higher.

FRONDICULARIA INTUMESCENS Borneman

Plate 6, figure 13

Frondicularia intumescens Borneman, 1854, p. 36, pl. 3, fig. 19a-c.
Frondicularia nitida, Franke (*non* Terquem), 1936, p. 68, pl. 7, figs. 1-3.
Frondicularia sacculus, Franke (*non* Terquem), 1936, p. 68, pl. 7, fig. 4.
Frondicularia intumescens, Franke, 1936, p. 67, pl. 6, fig. 27.

Frondicularia nitida, Bartenstein and Brand, 1937, p. 153, pl. 4, fig. 45.
Frondicularia intumescens, Bartenstein and Brand, 1937, p. 155, pl. 2b, fig. 19; pl. 4, fig. 55; pl. 5, fig. 35.

Although these specimens differ somewhat from the figure of the type, they compare well with some of the figures cited, and appear to fall within the limits of this highly variable species. The material consists of 3 small specimens, from the Forest Marble, possibly representing immature individuals. Previous records of this species are all from the Lias.

FRONDICULARIA LIGNARIA Terquem

Plate 6, figures 20-21

Frondicularia lignaria Terquem, 1866b, p. 480, pl. 19, fig. 14.
Frondicularia varians Terquem, 1866b, p. 480, pl. 19, fig. 15a-b.
non Frondicularia lignaria, Bartenstein and Brand, 1937, p. 152, many figures.
Frondicularia lignaria, Barnard, 1950a, p. 371, text-fig. 3g.

This species is distinguished by the tiny proloculus, sharply angular sutures and smooth margin. Barnard's figure shows a more rounded outline, sutures which are less angular, and greater overlap of the last chamber which composes about two-thirds of the test. Despite these differences there is good agreement, and the Lias form is considered identical.

This species is rare, and was observed only in the Lower Fuller's Earth Clay.

FRONDICULARIA NODOSARIA Terquem

Plate 7, figures 4-6

Frondicularia nodosaria Terquem, 1870b, p. 319, pl. 22, figs. 25-30.
Frondicularia nodosaria, Bartenstein and Brand, 1937, p. 155, pl. 12a, fig. 6; pl. 13, fig. 14; pl. 15a, fig. 21.
Lingulina nodosaria, Barnard, 1950b, p. 29, text-fig. 16.

The specimens are not as broad as those figured by Terquem, and the sutures are always distinctly arched. This species is similar to *Frondicularia oolithica* Terquem figured by Bartenstein and Brand (1937, p. 155, many figures), but the latter form consistently lacks costae or any visible striations.

FRONDICULARIA NODOSARIA Terquem var. A n.var.
Plate 7, figures 7-8

This variety differs from other forms of this species encountered in the present material in that the sutures are decidedly less convex and are almost transverse. Specimens are rare, and consist mostly of fragments. The observed distribution is confined to the Lower Fuller's Earth Clay.

FRONDICULARIA SPISSA Terquem
Plate 6, figures 22-24

Frondicularia spissa Terquem, 1870b, p. 317, pl. 22, fig. 10.
Frondicularia spatulata Terquem, 1870b, p. 317, pl. 22, figs. 11-17.
Frondicularia spatulata, Franke, 1936, p. 66, pl. 6, fig. 23.
Frondicularia spatulata, Bartenstein and Brand, 1937, p. 154, pl. 13, fig. 13a-b; pl. 14c, fig. 8; pl. 15a, fig. 19a-b; pl. 15c, fig. 9a-b.
Frondicularia lingulaeformis, Bartenstein and Brand (*non* Schwager), 1937, p. 154, pl. 14c, fig. 7.

This species is similar to *Frondicularia nodosaria,* but is generally broader than the latter species, and is not as constricted at the sutures.

Specimens are identical with those examined in the Terquem collection.

Genus SARACENARIA Defrance, 1824
SARACENARIA TRIQUETRA (Gumbel)

Cristellaria triquetra Gumbel, 1862, p. 225, pl. 3, fig. 28a-c.
Cristellaria (Saracenaria) triquetra Bartenstein and Brand, 1937, p. 170, pl. 14b, fig. 12a-b; pl. 15a, fig. 21a-b; pl. 15c, fig. 16.
Saracenella triquetra Barnard, 1953, p. 190, text-fig. B4a-b.

The delicate keel is barely visible on some specimens, probably because of preservation. Specimens also show marked differences in the degree of coil, some being almost completely uncoiled as in *Saracenella.*

Material deposited at M.C.Z. No. 3389.

Genus LAGENA Walker and Boys
LAGENA STRIATA (d'Orbigny)

Oolina striata d'Orbigny, 1839, p. 21, pl. 5, fig. 12.
Lagena natrii Blake, 1876, p. 453, pl. 8, fig. 8.
Lagena striata, Haeusler, 1890, pl. 8, fig. 12.

These rare specimens are small and have distinctly radiate apertures.

Material deposited at M.C.Z. No. 3390.

LAGENA GLOBOSA (Montagu)

Material deposited at M.C.Z. No. 3390.

Vermiculum globosum Montagu, 1803, in Ellis and Messina, *Catalogue of Foraminifera.*

Lagena globosa, Seibold and Seibold, 1953, p. 67, pl. 4, fig. 17.

This species differs from the preceding in being larger, more robust and lacking striations. It is rare in the English Bathonian.

Material deposited at M.C.Z. No. 3391.

Family POLYMORPHINIDAE

Genus EOGUTTULINA Cushman and Ozawa, 1930

EOGUTTULINA ANGUSTATA (Terquem)

Plate 7, figure 12

Polymorphina angustata Terquem, 1864b, p. 296, pl. 12, figs. 33-35.

Eoguttulina polygona, Bartenstein and Brand (*non* Terquem), 1937, p. 179, pl. 13, fig. 19a-c.

The test is small, compressed, and composed of four to five chambers arranged biserially for the most part, with a small spiral in the early portion.

Cushman and Ozawa (1930, p. 8) state that the chambers in this species are added in planes ninety degrees apart from one another, and the chamber arrangement is tetraserial. This interpretation is based on Terquem's type figures, which, however, show side views only, with no clear indications of the chamber arrangement.

This species is similar to *Eoguttulina liassica,* but is more compressed, has more depressed sutures, and later chambers that are arranged biserially. There is much variation, however, and additional material may show these species to be transitional.

This species is comparatively rare, although it occurs at a number of localities in various parts of the Bathonian.

EOGUTTULINA LIASSICA (Strickland)

Plate 7, figures 9-11

Polymorphina liassica Strickland, 1846, p. 31, text fig. b.
Eoguttulina liassica, Cushman and Ozawa, 1930, p. 7, pl. 1, fig. 2a-c.
Eoguttulina liassica, Bartenstein and Brand, 1937, p. 178, pl. 1a, fig. 24a-b; pl. 2a, fig. 23; pl. 2b, fig. 35; pl. 3, fig. 49; pl. 4, fig. 74a-b; pl. 5, fig. 69a-b.
Eoguttulina oolithica Bartenstein and Brand, 1937, p. 179, pl. 8, fig. 34a-b; pl. 10, fig. 43a-b; pl. 11a, fig. 18a-c; pl. 11b, fig. 24a-b; pl. 12b, fig. 18; pl. 15a, fig. 37a-b.

Most often the tests consist of three chambers, but occasional specimens have four or five chambers. Each of these is farther removed from the base than the previous one, and the arrangement is vaguely reminiscent of a spiral. The test contains an internal tube which is clearly visible in the well preserved specimens under transmitted light.

This species is common throughout the Bathonian, and is particularly abundant in Northamptonshire and Rutland.

Genus PALEOPOLYMORPHINA Cushman and Ozawa, 1930

PALEOPOLYMORPHINA PLEUROSTOMELLOIDES (Franke)

Plate 7, figure 13

Polymorphina pleurostomelloides Franke, 1928, p. 121, pl. 11, fig. 11.
Paleopolymorphina pleurostomelloides, Cushman and Ozawa, 1930, p. 112, pl. 28, fig. 5a-b.

This species was selected by Cushman and Ozawa as the genotype of *Paleopolymorphina* and their description of the species is as follows: "Test small, more or less cylindrical, tapering towards the initial end; chambers inflated, oval, but little embracing, alternating, arranged in an entirely biserial series, each farther removed from the base; sutures oblique, much depressed, distinct, wall smooth; aperture radiate." However, the description of the genus is as follows: "Test with early chambers spiral, later ones becoming biserial-Genotype-*Polymorphina pleurostomelloides* (Franke)." It can be seen that the description of the genotype does not correspond to that of the genus, as this species is biserial throughout.

This species is very rare in the Bathonian, but specimens included here compare well with figures of the type from the Cretaceous, except that the chambers of the Bathonian forms are somewhat more elongate, tending to become uniserial in the latest portion, and there are six, instead of seven chambers.

Genus GLOBULINA d'Orbigny, 1839

GLOBULINA sp.

Plate 7, figure 14

Rare, tiny, globular specimens are best referred to this genus. The sutures are indistinct, so that the growth plan is uncertain. Superficially, however, they closely resemble other forms of *Globulina*.

Family HETEROHELICIDAE

Genus PLECTOFRONDICULARIA Liebus, 1903

PLECTOFRONDICULARIA PARADOXA (Berthelin)

Plate 7, figure 16

Frondicularia paradoxa Berthelin, 1879, p. 33, pl. 1, figs. 12-17.
Frondicularia paradoxa, Issler, 1908, p. 58, pl. 3, figs. 119-121.
Flabellina paradoxa, Bartenstein and Brand, 1937, p. 168, pl. 4, fig. 63a-c.
Plectofrondicularia paradoxa, Macfadyen, 1941, p. 66, pl. 4, figs. 67-68.

The present material consists of two specimens, one of which is a microsphere and the other a megalosphere. The microsphere is the larger of the two, and has minute spines projecting at the margins. Both specimens agree well with those previously described from the Lias, except that in these the biserial portion constitutes a smaller part of the test than appears to be typical of this species.

Family BULIMINIDAE

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA RHUMBLERI Franke

Plate 7, figure 15

Bolivina nitida, Haeusler (*non* Brady), 1890, p. 79, pl. 12, figs. 38-39.
Bolivina rhumbleri Franke, 1936, p. 126, pl. 12, fig. 21.

Bolivina rhumbleri rhumbleri, Bartenstein and Brand, 1937, p. 184, pl. 4, fig. 73a-c; pl. 5, fig. 72a-c.

Specimens are very rare. The aperture is slit-like, and the test is smooth with flush sutures. The specimens compare best with Haeusler's figures, and are slimmer and more fusiform than that illustrated by Franke.

Family ROTALIIDAE

Genus SPIRILLINA Ehrenberg, 1843

SPIRILLINA INFIMA (Strickland)

Orbis infimus Strickland, 1846, p. 30, text fig. A.

Spirillina polygyrata, Bartenstein and Brand (*non* Gumbel), 1937, p. 131, pl. 4, fig. 10; pl. 6, fig. 7; pl. 14c, fig. 3; pl. 15a, fig. 2a-c; pl. 15c, fig. 1a-d.

Spirillina punctilata, Bartenstein and Brand (*non* Terquem), 1937, p. 132, pl. 12b, fig. 2a-d; pl. 14c, fig. 4a-b.

Included here are small, planispiral tubular forms which have thin walls and a vitreous luster. When observed under high power pores are visible on some tests. Poorly preserved specimens in which the wall has been altered are inseparable from *Cornuspira* or *Ammodiscus*. The vitreous appearance of the wall does not offer a clue to the generic position, as Mr. McNichol of University College, London, has observed that altered specimens of *Cornuspira* sometimes have a vitreous luster, but can be seen to be imperforate under very high magnifications (personal communication, 1955). The problem of separation, therefore, is difficult.

A similar form is *Spirillina tenuissima* Gumbel. Topotypes of this species, however, are considerably larger and more robust.

The forms included here are extremely common throughout the Bathonian.

Genus PATELLINA Williamson, 1858

PATELLINA OOLITHICA Terquem

Plate 7, figures 21-22

Patellina oolithica Terquem, 1883, p. 382, pl. 45, figs. 3-4.

Spirillina oolithica Terquem, 1886, p. 59, pl. 7, figs. 2-4.

The present specimens resemble *Trocholina nidiformis* (Bruckman), but the last whorl is divided into four chambers, and there are no clearly defined pillars on the ventral surface. The Jurassic forms of this genus are clearly more simple than their recent counterparts, particularly the genotype, *Patellina corrugata* Williamson. However, the authority of Cushman (1930, p. 14) is followed in retaining the Jurassic forms in this genus.

Genus DISCORBIS Lamarck, 1804

DISCORBIS DREHERI Bartenstein

Plate 7, figures 23-25

Discorbis dreheri Bartenstein *in* Bartenstein and Brand, 1937, p. 192, pl. 6, fig. 45a-b; pl. 8, fig. 42a-e; pl. 10, fig. 47a-d.

A number of specimens collected from various localities compare well with the figures cited, but the preservation is rather poor, and the structure is not entirely visible. Most individuals are plano-convex, although some are biconvex, and the ventral margin is slightly indented. Most of the specimens are covered with a layer of calcite which obscures many of the surface features and the aperture. On two specimens, however, a slit-like aperture can be seen which extends along the umbilical margin of the last chamber. The sutures are flush or slightly depressed, and the chambers are slightly bulbous.

Hofker (1953) has referred this species to *Rheinholdella* on the basis of tooth plate structure. Several sections were made from the present material, but no internal structure was revealed, possibly due to poor preservation.

Genus EPISTOMINA Terquem, 1883

EPISTOMINA STELLIGERA (Reuss)

Plate 7, figures 17-20

Rotalina stelligera Reuss, 1854, p. 69, pl. 25, fig. 15a-c.

Epistomina stelligera, Bruckman, 1904, p. 23, pl. 4, figs. 10-11.

Epistomina caracolla, Paalzow (*non* Roemer), 1932, p. 142, pl. 11, figs. 12-14.

Epistomina stelligera, Bartenstein and Brand, 1937, p. 191, pl. 11a, fig. 21a-c; pl. 11c, fig. 3a-f; pl. 12a, fig. 27a-b; pl. 12b, fig. 20a-b; pl. 13, fig. 27a-d; pl. 14b, fig. 21a-c; pl. 14c, fig. 18a-b.

Many of the specimens are coated with secondary calcite, and much of the structure is not visible. However, on those tests which are free of this, the peripheral aperture can be seen to be situated close to the ventral margin. No aperture was observed at the base of the apertural face. The keel is very small, delicate, and is distinctly serrate; however in most specimens the keel is not present, probably because of erosion. A poorly developed reticulate pattern appears on the umbonal region of some specimens.

This species resembles *Epistomina mosquensis,* but is considerably smaller and lacks the heavy sculpturing on the umbonal region.

Family ANOMALINIDAE

Genus ANOMALINA, d'Orbigny, 1826

ANOMALINA LIASSICA Issler

Plate 7, figure 26

Anomalina liassica Issler, 1908, p. 93, pl. 7, figs. 331-332.
Anomalina liassica, Franke, 1936, p. 128, pl. 12, figs. 27a-b.
Anomalina liassica, Bartenstein and Brand, 1937, p. 191, pl. 6, fig. 44; pl. 8, fig. 41.

The material consists of one specimen which is very small and has six chambers in the last whorl. The test is evolute, and only slightly trochoid. The aperture is small and slit-like and is situated at the base of the last chamber, extending slightly on the dorsal side. The specimen is smaller than those figured by Issler and is less stout, but is otherwise identical.

The specimen was recovered from the Upper Fuller's Earth Clay at the Combe Hay Fuller's Earth Works, Bath.

BIBLIOGRAPHY

ADAMS, C. G.
1957. A study of the morphology and variation of some Upper Lias Foraminifera. Micropaleontology, v. 3, pp. 205-226.

ARKELL, W. J.
1933. The Jurassic System in Great Britain. Oxford Press, 681 pp.
1947a. The geology of the country around Weymouth, Swanage, Corfe and Lulworth. Mem. Geol. Surv. Great Britain, 386 pp.
1947b. The geology of Oxford. Oxford Press, 267 pp.

1951. The English Bathonian Ammonites. Part I. Pal. Soc., v. 104, pp. 1-46.
1956. Jurassic geology of the world. Oliver and Boyd (London), 806 pp.
1957. Ammonites from the Fuller's Earth Rock, Whatley, Somerset. Geol. Mag., v. 94, pp. 322-325.

Arkell, W. J. and D. T. Donovan
1952. The Fuller's Earth of the Cotswolds and its relation to the Great Oolite. Quart. Jour. Geol. Soc. London, v. 107, pp. 227-253.

Barnard, T.
1950a. Foraminifera from the Lower Lias of the Dorset Coast. Quart. Jour. Geol. Soc. London, v. 105, pp. 347-391.
1950b. Foraminifera from the Upper Lias of Byfield, Northamptonshire. Quart. Jour. Geol. Soc. London, v. 106, pp. 1-36.
1952. Foraminifera from the Upper Oxford Clay, Huntingtonshire. Proc. Geol. Assoc., v. 63, pp. 336-350.
1953. Foraminifera from the Upper Oxford Clay (Jurassic) of Redcliff Point, near Weymouth, England. Proc. Geol. Assoc., v. 64, pp. 183-197.
1956. Some Lingulinae from the Lias of England. Micropaleontology, v. 2, pp. 271-282.
1957. *Frondicularia* from the Lower Lias of England. Micropaleontology, v. 3, pp. 171-181.

Bartenstein, H.
1948. Taxonomische Abgrenzung der Foraminiferen-Gattungen *Palmula* Lea, *Flabellina* d'Orbigny und *Falsopalmula* n.g., gleizeitig eine Revision der Jura-arten von ''*Flabellina*.'' Senckenbergiana, v. 28, pp. 119-137.

—— and E. Brand
1937. Mikro-paläontologische Untersuchungen zur Stratigraphie des nordwest-deutschen Lias und Doggers. Abh. Senckenb. Naturf. Ges., no. 439, pp. 1-224.

Berthelin, G.
1879. Foraminifères du Lias Moyen de la Vendée. Rev. Mag. Zool., 3rd ser., v. 7, pp. 24-41.

Blake, J. F.
1876. Class Rhizopoda. *In*: Tate and Blake, The Yorkshire Lias. London, pp. 449-473.

BORNEMAN, J. G.

1854. Über die Liasformation in der Umgegend von Göttingen und ihre organischen Einschlüsse. Diss. (Berlin), pp. 1-45.

BRADY, H. B.

1867. Foraminifera. *In* Moore, C., On the Middle and Upper Lias of southwest England. Proc. Somerset. Archaeol. Nat. Hist. Soc., 1865-66, v. 13, pp. 119-244.

BROTZEN, F.

1953. Problems in the nomenclature of the Foraminifera. Micropaleontologist, v. 7, pp. 35-38.

BRUCKMAN, R.

1904. Die Foraminiferen des litauische-kurischen Jura. Schr. Phys.-Ökon. Gesell. Königsberg, v. 45, pp. 1-36.

BUCKMAN, S. S.

1922. Jurassic chronology. II. Preliminary studies. Certain Jurassic strata near Eypesmouth (Dorset); the Junction Bed of Watton Cliff and associated rocks. Quart. Jour. Geol. Soc. London, v. 78, pp. 378-436.

CHATWIN, C. P.

1948. British Regional Geology. The Hampshire Basin and adjoining areas. 2nd ed., Geol. Surv. and Mus. London, 99 pp.

COX, L. R.

1941. Report of the Easter Field Meeting, 1940, Bath. Proc. Geol. Assoc., v. 52, pp. 16-35.

CUSHMAN, J. A.

1918-1931. The Foraminifera of the Atlantic Ocean. Bull. U. S. Nat. Museum, v. 104, pts. 1-8, 106 pp.

1930. Some notes on the genus *Patellina*. Contr. Cushman Lab. Foram. Res., v. 6, pp. 11-17.

1937. A monograph of the foraminiferal family Valvulinidae. Cushman Lab. Foram. Res., Spec. Publ. 8, 210 pp.

1946. A supplement to the monograph of the foraminiferal family Verneuillinidae. Cushman Lab. Foram. Res., Spec. Publ. 7A, 43 pp.

1948. Foraminifera, their classification and economic use. Harvard Press, 4th ed., 605 pp.

—— and Y. OZAWA

1930. A monograph of the foraminiferal family Polymorphinidae, Recent and fossil. Proc. U. S. Nat. Museum, v. 77, art. 6, 185 pp.

DEEKE, W.

1884. Die Foraminiferenfauna der Zone des *Stephanoceras humphriesianum* im Unter-Elsass. Abh. Spezialk. Els. Lothring., v. 4, pp. 1-68.

1886. Les Foraminifères de l'Oxfordien des environs de Montbeliard (Doubs). *In* Kilian, W., Notes géologiques sur le Jura du Doubs, pt. 4. Mém. Soc. d'Emul. Montbeliard, v. 16, pp. 293-335.

1898. Foraminiferen aus den Dobbertiner Jurensis-Mergeln. Archiv. v. Freund. Naturg. Mecklenburg, Gustrow, pp. 48-57.

EDMUNDS, F. H. and K. P. OAKLEY

1947. British Regional Geology. The Central England District. 2nd ed. Geol. Surv. and Mus. London, 80 pp.

ELLIS, B. F. and A. R. MESSINA

1940-1958. Catalogue of Foraminifera. Spec. Publ. Amer. Mus. Nat. Hist., New York.

FRANKE, A.

1928. Die Foraminiferen der oberen Kreide Nord- und Mitteldeutschlands. Abh. Preus. Geol. Landesanst., n.s., no. 111, pp. 1-207.

1936. Die Foraminiferenfaunen des Lias. Abh. Preus. Geol. Landesanst., n.s., no. 169, 138 pp.

FRENTZEN, K.

1941. Die Foraminiferenfaunen des Lias, Doggers und Malms der Umgegend von Blumberg (Oberes Wutachgebiet). Beitr. Naturk. Forsch. Oberheing. Karlsruhe, pp. 125-402.

1944. Die agglutierenden Foraminiferen der Bermensdorf Schichten (*Transversarius*-Zone in Schwammfazies) des Gebietes um Blumberg in Baden. Paläont. Zeitschr., v. 23, pp. 317-342.

GALLOWAY, J. J.

1933. A manual of Foraminifera. Bloomington (Indiana), 483 pp.

GREEN, G. W. and R. V. MELVILLE

1956. The stratigraphy of the Stowell Park Borehole. Bull. Geol. Surv. Great Britain, no. 11, pp. 1-33.

GUMBEL, C. W.

1862. Die Streitberger Schwammlager und ihre Foraminifereneinschlüsse. Jahrheft. vaterl. Naturkd. Württemberg, v. 18, pp. 192-238.

HAEUSLER, J.

1890. Monographie der Foraminiferen Fauna der Schweizerischen *Transversarius*-Zone. Abh. schweiz. paläont. Ges., v. 17, pp. 1-134.

HOFKER, J.

1953. The genus *Epistomaria* Galloway, 1933 and the genus *Epistomariodes* Uchio, 1952. Paläont. Zeitschr., v. 27, pp. 129-142.

ISSLER, A.

1908. Beiträge zur Stratigraphie und Mikrofauna des Lias in Schwaben. Palaeontographica, v. 55, pp. 1-104.

JONES, T. R. and W. K. PARKER

1860. On some fossil Foraminifera from Chellaston near Derby. Quart. Jour. Geol. Soc. London, v. 16, pp. 452-458.

KELLAWAY, G. A. and F. B. A. WELCH

1948. British Regional Geology. Bristol and Gloucester District. 2nd ed. Geol. Surv. and Mus. London, 99 pp.

KELLAWAY, G. A. and V. WILSON

1941. An outline of the geology of Yeovil, Sherborne and Sparkford Vale. Proc. Geol. Assoc., v. 52, pp. 131-174.

KLAHN, H.

1921. Die Foraminiferengeschlechter *Rhabdogonium, Frondicularia* und *Cristellaria* der elsassischen und badischen Juraschichten. Freiburg, pp. 1-75.

LOEBLICH, A. R. and H. TAPPAN

1952. The foraminiferal genus *Triplasia* Reuss, 1854. Smithson. Misc. Coll., v. 117, no. 5, 61 pp.

MACFADYEN, F. A.

1935. Jurassic Foraminifera. *In*: The Mesozoic paleontology of British Somaliland. London. Pt. II. pp. 7-20.

1936. D'Orbigny's Lias Foraminifera. Jour. Roy. Micros. Soc., ser. 3, v. 56, pp. 147-153.

1941. Foraminifera from the Green Ammonite Beds, Lower Lias, of Dorset. Philos. Trans. Roy. Soc. London, ser. B, Biol. Sci., no. 576, v. 231, pp. 1-73.

MUIR-WOOD, H. M.

1936. A monograph of the Brachiopoda of the British Great Oolite Series. Pt. I, The Brachiopoda of the Fuller's Earth. Palaeont. Soc., v. 89, pp. 1-144.

D'ORBIGNY, A.

1826. Tableau méthodique de la classe des Céphalopodes. Ann. Sci. Nat., ser. 1, v. 7, pp. 96-314.

1839. Voyage dans l'Amérique meridionale. Paris-Strasburg, pp. 1-86.

1846. Die fossilen Foraminiferen des Tertiaeren Beckens von Wien. Paris, pp. 1-312.

PAALZOW, R.

1917. Beiträge zur Kenntnis der Foraminiferenfauna der untern Weissen Jura in Süddeutschenland. Abh. Nat. Geol. Nürnberg, v. 19, pp. 203-248.

1922. Die Foraminiferen der *Parkinsoni*-Mergel von Heidenheim am Hahnemkamm. Abh. Naturk. Ges. Nürnberg, v. 22, pp. 1-35.

1932. Die Foraminiferen aus den *Transversarius*-Schichten und *Impressa*-Tonen der Nordostlichen Schwabischen Alb. Jahresh. vaterl. Naturk. Württemberg, v. 88, pp. 81-142.

PAYARD, J.

1947. La faune des Foraminifères du Lias Superieur du Détroit Poitevin. Univ. Paris, thèsis, 254 pp.

REUSS, A. E.

1854. Beiträge zur Charakteristik der Kreideschichten in den Ostalpen im Gosauthale und am Wolfgangsee. Denkschr. K. Akad. Wiss., v. 7, pp. 1-156.

1863a. Die Foraminiferen des norddeutschen Hils und Gault. Sitzber. Math.-nat. Cl. K. Akad. Wiss., v. 46, Abt. 1, pp. 5-100.

1863b. Die Foraminiferen-Familie der Lagenideen. Sitzber. Math. nat. Cl. K. Akad. Wiss., Abt. 1, pp. 308-342.

RICHARDSON, L.

1907. The Inferior Oolite and contiguous deposits of the Bath-Doulting District. Quart. Jour. Geol. Soc. London, v. 63, pp. 383-423.

1909. Excursion to the Frome District, Somerset. Proc. Geol. Assoc., v. 21, pp. 209-228.

1910. On a Fuller's Earth section at Combe Hay, near Bath. Proc. Geol. Assoc., v. 21, pp. 425-428.

1911a. On the sections of the Forest Marble and Great Oolite on the railway between Cirencester and Chedworth, Gloucestershire. Proc. Geol. Assoc., v. 22, pp. 95-115.

1911b. The Inferior Oolite and contiguous deposits of the Chipping-Norton district, Oxfordshire. Proc. Cottes. Nat. Field Club, v. 17, pp. 195-231.

1929. The country around Moreton in Marsh. Mem. Geol. Surv. England and Wales, 162 pp.

1933. The country around Cirencester. Mem. Geol. Surv. England and Wales, 116 pp.

RICHARDSON, L., W. J. ARKELL, and H. G. DINES
1946. The geology of the country around Whitney. Mem. Geol. Surv. Great Britain, 150 pp.

ROEMER, F. A.
1839. Die Versteinerungen des norddeutschen Oolithen-Gebirges. Hanover, 59 pp.
1841. Die Versteinerungen des norddeutschen Kreidegebirges. Hanover, 145 pp.

SCHLUMBERGER, C.
1893. Monographie des Miliolidées du Golfe de Marseille. Mém. Soc. Zool. France, v. 6, pp. 199-228.

SCHWAGER, C.
1865. Beitrag zur Kenntnis der mikroskopischen Fauna jurassischer Schichten. Jahresh. vaterl. Naturk. Württemberg, v. 21, pp. 82-151.
1867. *In*: Waagen, W., Über die Zone des *Ammonites sowerbyi*. Geogn.-Paläon. Beiträge v. Bennecke, v. 1, pp. 654-668.

SEIBOLD, E. and I. SEIBOLD
1953. Foraminiferenfauna und Kalkgehalt eines Profils im gebankten Unteren Malm Schwabens. Abh. Neues Jahrb. Geol. Paläont., v. 98, pp. 28-76.
1955. Revision der Foraminiferen-Bearbeitung C. W. Gumbels (1862) aus den Streitberger Schwamm-Mergeln (Oberfranken, Untern Malm). Abh. Neues Jahrb. Geol. Paläont., v. 101, pp. 91-134.
1956. Revision der Foraminiferen-Bearbeitung C. Schwagers (1865) aus den Impressaschichten (Unterer Malm) Süddeutschlands. Abh. Neues Jahrb. Geol. Paläont., v. 103, pp. 91-154.

STRICKLAND, H. E.
1846. On two species of microscopic shells found in the Lias. Quart. Jour. Geol. Soc. London, v. 2, pp. 30-31.

SYLVESTER-BRADLEY, P. C.
1957. The Forest Marble of Dorset. Proc. Geol. Soc. London, No. 1556, pp. 26-28.

SYLVESTER-BRADLEY, P. C. and F. HODSON
1957. The Fuller's Earth of Whatley, Somerset. Geol. Mag., v. 94, pp. 312-322.

TAPPAN, H.
1955. Foraminifera from the Arctic slope of Alaska. Part II. Jurassic Foraminifera. U. S. Geol. Surv. Prof. Pap., v. 236-B, pp. 21-90.

TERQUEM, O.

1858. Recherches sur les Foraminifères du Lias du Départements de la Moselle. Mém. Imp. Acad. Metz, v. 39, pp. 563-656.

1862. Recherches sur les Foraminifères de l'Etage Moyen et de l'Étage Inferieur du Lias. Mém. Imp. Acad. Metz, v. 42, pp. 415-466.

1864a. Troisième Mémoire sur les Foraminifères du Lias des Départments de la Moselle de la Côte d'Or, du Rhône, de la Vienne et du Calvados. Mém. Imp. Acad. Metz, v. 44, pp. 147-228.

1864b. Quatrième Mémoire sur les Foraminifères du Lias, comprenant les Polymorphines des Départements de la Moselle, de la Côte d'Or et de l'Indre. Mém. Imp. Acad. Metz, v. 44, pp. 229-308.

1866a. Cinquième Mémoire sur les Foraminifères du Lias des Départements de la Moselle, de la Côte d'Or et de l'Indre. Mém. Imp. Acad. Metz, pp. 309-454.

1866b. Sixième Mémoire sur les Foraminifères du Lias des Départements de l'Indre et de la Moselle. Mém. Imp. Acad. Metz, pp. 455-532.

1868. Premier Mémoire sur les Foraminifères du Système Oolithique Étude du Fuller's-Earth de la Moselle. Bull. Soc. Hist. Nat. Moselle, v. 11, pp. 1-138.

1870a. Deuxième Mémoire sur les Foraminifères du Système Oolithique zone à *Ammonites parkinsoni* de la Moselle. Mém. Imp. Acad. Metz, v. 50, pp. 403-456.

1870b. Troisième Mémoire sur les Foraminifères du Système Oolithique comprenant les genres *Frondicularia, Flabellina, Nodosaria*, etc., de la zone a *Ammonites parkinsoni* de Fontoy (Moselle). Mém. Imp. Acad. Metz. v. 51, pp. 299-380.

1883. Cinquième Mémoire sur les Foraminifères du Système Oolithique de la zone *Ammonites parkinsoni* de Fontoy (Moselle). Paris, pp. 339-406.

1886. Les Foraminifères et les Ostracodes du Fuller's-Earth des environs de Varsovie. Mém. Soc. Géol. France, ser. 3, v. 4, 112 pp.

TERQUEM, O. and G. BERTHELIN

1875. Étude microscopique des marnes du Lias Moyen d'Essey-les-Nancy, zone inférieure de l'Assise à *Ammonites margaritatus*. Mém. Soc. Géol. France, ser. 2, v. 10, 126 pp.

UHLIG, V.

1883. Über Foraminiferen aus den rjason'schen Ornatenthon. Jahrb. K.K. geol. Reichsanstalt, v. 33, pp. 735-774.

USBECK, I.
1952. Zur Kenntnis von Mikrofauna and Stratigraphie im Untern Lias Alpha Schwabens. Abh. Neues Jahrb. Geol. Paläont., v. 95, pp. 371-476.

WISNIOWSKI, T.
1890. Mikrofauna ilow ornatowych okolicy Krakowa. I. Otwornice górnego Kellowayu w Grojcu. Pam. Akad. Umiej. Krakówie, v. 17, pp. 181-242.

WOOD, A. and T. BARNARD
1946. *Ophthalmidium*: a study of nomenclature variation and evolution in the Foraminifera. Quart. Jour. Geol. Soc. London, v. 102, pp. 77-109.

WOODWARD, H. B.
1894. The Jurassic rocks of Britain. IV. The lower Ooolitic rocks of England (Yorkshire excepted). Mem. Geol. Surv. United Kingdom, 628 pp.

CHECK LIST OF BATHONIAN FORAMINIFERA FROM THE DORSET COAST AREA, DORSETSHIRE

LITHOLOGIC UNIT	Scroff	LOWER FULLER'S EARTH				WATTONENSIS BEDS								UPPER FULLER'S EARTH		Elongata Beds															Boueti Bed	FOREST MARBLE								
Species / Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ammobaculites agglutinans															□	○	●	□	○	■	○		○	○				○	○											
Ammobaculites fontinensis																									○									○						
Bolivina rhumbleri									○	○																														
Citharina colliezi	○		●			●	●			○		○																												
Citharina heteropleura																			○					○																
Citharina sp						○																																		
Cornuspira liasina	□	□	□	■	■	■	□	●	□	■	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○	●	○	○	○	●	○	□	□	●	○
Dentalina c f D bicornis															○																									
Dentalina communis					○	●	○	○	●	○	○	○						○			○	●	●					●		○										
Dentalina aff D communis																			○		○			○																
Dentalina conferta		○				□	○		○	□					○			□	●	●	○	■	□	□	□	●	□	■	□	■										
Dentalina intorta																		□	●	●	○	■	□	□	□	●	□	■	□	■		●	○	□	●	■	□	○	○	○
Dentalina mucronata																			○			○		●	○				○											
Dentalina propinqua												●	○					■		□		□						●												
Dentalina nodigera												○							○		○																			
Dentalina oolithica																		■			○	●	●		○	□		●		●				□					○	○
Dentalina subplana				○	○			○	○	○	■	●																												
Discorbis dreheri		■		○									■					○	■	□	□		●														○			
Eoguttulina angustata					○																														○	○		○		○
Eoguttulina liassica		○		○		○			●				○			●	○	○	●			●	□	□				●		○			○	●	○	○	○	○		○
Epistomina stellegera																							●			■	■													
Flabellomina althoffi																									●															
Frondicularia dentaliformis																		○	○		○	○	○											○				●		
Frondicularia intumescens																																	○	○			○			
Frondicularia lignaria			○	○																																				
Frondicularia nodosaria									○	○	○	○	○			○			●			□			●	●		●		●	●					○	○		○	○
Frondicularia nodosaria var A	○		○	○	○																																			
Frondicularia spissa						○	○		○	○								○				○	●	●	●			○	○			○					○		○	
Haplophragmium suprajurrassicum							○												○														○							
Lagena striata										○																							○							
Lenticulina galeata	■	○	■	□	■																																			
Lenticulina munsteri	●	■	○	□	○	□	■	□	●	■	■	■	■			○	●					●		■		□		○	○		●					○				
Lenticulina quenstedti						○	□	○	●	○	○	○			○				○	○	○	○		○	●	○					○							○		
Lenticulina quenstedti var A	■	○	○																																					
Lenticulina quenstedti var B								○		●			●	○																										
Lenticulina sowerbyi			○		○																																			
Lenticulina subalata		●					□	○	●	●	○	○	○	□	■	○		○	■	●	□	○	□	■	■	■				●	●									
Lenticulina tricarinella	●		●				□			■	●	○	○																											
Lenticulina tricarinella var A																								○	○		○													
Lenticulina turgida						□	●	○		□	○	○	○		○															○	○		○		○	○		●		
Lenticulina varians																			○		○	○					●		○			□	○	○			○			
Lingulina dentaliformis	○										○								○		○			○														○		
Lingulina laevissima									○									●		○							○								○	○	○		○	
Marginulina deslongchampsi	●					○					○																													
Marginulina terquemi	□									○		○	○								●	●	○	□		○		○										○		
Mesallina dorsetensis																														●	■	■	■	■	■	■	□	●		
Nodosaria clavula																																		○						
Nodosaria hortensis	□	□	■	○	□		□	○			○	○	○						○			○		□	○	●	○	○		○	●	○	○				○	●		○
Nodosaria ingens												○																												
Nodosaria liassica	○		○		○																																			
Nodosaria opalini				○	○		○								○	○		□	●	●	○	■	○	○	□	■	●	●	○	□	○	○	○	○	●	●	○	■	■	○
Nodosaria pectinata						○							○					○		○	○		○	●				○												
Nodosaria plicatilis						○	○		○		○	●	○																								○	○	○	
Nodosaria aff N prima							●						○																											
Patellina oolithica	○				○				●	●	○															○			□	□	○				○	□	○	□		
Planularia anceps									○	○	○	○																												
Planularia beierana	■	○	■	□	□	□	■	○	○	■	○								□	○	□	○	●	○	●	□		○				○		○		●	○	○		
Planularia eugenii			○	○	●			○				○	○																											
Planularia inconstans							○																																	
Planularia protracta		○							●														○								○	○				○	○			
Planularia sp A							○																																	
Problematina c f P liassica															○																									
Pseudonodosaria hybrida																		●		○	○				●					○				○				○		
Pseudonodosaria oviformis				○																																				
Pseudonodosaria pupoides					○	○																			○	●				○			○	●			○		○	○
Pseudonodosaria vulgata									○										○							●		○	○			○						○		
Reophax multilocularis															○			○	○												○									
Saracenaria triquetra	○												○																											
Spirillina infima	●	□	□	■	■	■	●	○	○	■	●	□	●		○			●	○	○	●	●	○	●	●	●	□	□	□	○	●	●	●	●	●	●	●	■	●	●
Spiroloculina lanceolata			●															□				○	●		○	□		●	□	□								○		
Spiropthalmidium concentricum	□	●	□	○	●						□	□	○	○	□			■	●		○	●	●	■	□	■	□	●	●	□	■		○	○	●	□		●	●	
Textularia jurassica							○																	○					○											
Tristix suprajurassicum							○			●	○	○																	○											
Triplasia bartensteini																					○																			
Trochammina globigeriniformis		○						○	○							○		○		□			○			○														
Trochammina haeusleri																									○					○	□									
Vaginulina clathrata	○		●	○	○																																			
Vaginulina clathrata sypensa							○	○	○	●	○	○																		○	○									
Vaginulina contracta	●				○																							○	○	●							○	●		○
Vaginulina harpa		○				○						○																												
Vaginulina c f V hechti										○																														
Vaginulina legumen					○		○																			○	○					○								
Vaginulina macilenta			○																																					
Vaginulina sp							○	○	○	●																														
Verneuilina mauritii																	○																							

SUPPLEMENTARY LOCALITY DATA

Dorset Coast

Sample No. shown in Table 1	Field sample No.
1	DoBu4
2	DoBu3
3	DoBu5
4	DoBu1
5	DoBu2
6	DoEm0
7	DoEm1
8	DoEm2
9	DoEm3
10	DoEm4
11	DoEm5
12	DoEm6
13	DoEm7
14	DoH2
15	DoH1
16	DoH3
17	DoH4
18	DoW1
19	DoC10
20	DoC9
21	DoC8
22	DoC7
23	DoC6
24	DoC5
25	DoC4
26	DoC2
27	DoC1
28	DoH7
29	DoH6
30	DoH5
31	DoH8
32	DoWA
33	DoWC
34	DoWB
35	DoWD
36	DoWE
37	DoWG
38	DoWF
39	DoWH
40	DoWI

Table 2. **Foraminifera from the Lower Fuller's Earth Clay at Midford (Richardson, 1910, p. 427).**

Sample BMF1

Bolivina rhumbleri	Rare
Cornuspira liasina	Common
Eoguttulina liassica	Rare
Frondicularia nodosaria var. A	Few
Haplophragmium suprajurassicum	Rare
Lenticulina munsteri	Few
Lenticulina quenstedti	Abundant
Lenticulina quenstedti var. A	Rare
Lenticulina tricarinella	Rare
Lenticulina turgida	Rare
Nodosaria hortensis	Few
Nodosaria opalini	Rare
Planularia beierana	Common
Pseudonodosaria pupoides	Rare
Pseudonodosaria vulgata	Rare
Spirillina infima	Few
Spirophthalmidium concentricum	Common
Vaginulina clathrata	Rare

Sample BMF2

Dentalina oolithica	Rare
Eoguttulina liassica	Rare
Frondicularia nodosaria	Rare
Lenticulina galeata	Few
Lenticulina quenstedti	Common
Lenticulina quenstedti var. A	Few
Lenticulina tricarinella	Common
Lenticulina turgida	Rare
Nodosaria hortensis	Rare
Nodosaria opalini	Rare
Patellina oolithica	Few
Planularia protracta	Few
Pseudonodosaria vulgata	Rare
Reophax multilocularis	Rare
Saracenaria triquetra	Rare
Spirillina infima	Abundant
Trochammina haeusleri	Rare
Vaginulina clathrata	Few

Table 3. Foraminifera from the Lower Fuller's Earth Clay, at the road cut between Maperton and Charleton-Horetorne (Richardson, 1909, p. 213).

Sample BaM1

Cornuspira liasina	Abundant
Dentalina communis	Rare
Dentalina mucronata	Rare
Dentalina oolithica	Rare
Dentalina propinqua	Rare
Dentalina subplana	Few
Eoguttulina liassica	Few
Frondicularia dentaliniformis ?	Rare
Frondicularia nodosaria	Rare
Frondicularia spissa	Rare
Lenticulina munsteri	Common
Lingulina laevissima	Rare
Marginulina terquemi	Rare
Nodosaria opalini	Rare
Nodosaria aff. N. prima	Common
Patellina oolithica	Few
Planularia beierana	Abundant
Saracenaria triquetra	Few
Spirophthalmidium concentricum	Common

Table 4. **Foraminifera from the Lower Fuller's Earth Clay?, at Box.**

Sample BC012 (about 12 feet below the contact of the Fuller's Earth Rock?)

Citharina colliezi	Rare
Dentalina communis	Few
Dentalina subplana	Rare
Eoguttulina liassica	Few
Lenticulina munsteri	Common
Lenticulina subalata	Rare
Nodosaria opalini	Rare
Planularia beierana	Abundant
Spirillina infima	Rare
Vaginulina clathrata eypensa	Few
Vaginulina sp. A	Rare

Sample BC014 (about 5 feet below contact of Fuller's Earth Rock?)

Dentalina intorta	Few
Lenticulina munsteri	Rare
Lenticulina subalata	Rare
Lenticulina tricarinella	Rare
Lingulina laevissima	Rare
Patellina oolithica	Rare
Planularia beierana	Abundant
Pseudonodosaria pupoides	Rare

Table 5. Foraminifera from the Fuller's Earth Rock, between Maperton and Charleton-Horetorne (Richardson, 1909, p. 213).

1—(Sample BaM2) In marls of bed f, about 1½ ft. below bed e.

2—(Sample BaM3) In clay parting of bed e, about 2 ft. above bed f.

3—(Sample BaM4) In "Ornithella marl."

A, abundant; C, common; F, few; R, rare.

	1	2	3
Citharina colliezi		R	
Dentalina conferta		R	
Dentalina intorta	R	R	
Dentalina oolithica		R	
Dentalina propinqua	R	R	
Dentalina subplana	R	R	R
Eoguttulina liassica	R	R	
Frondicularia dentaliniformis	R	R	
Frondicularia nodosaria	R	R	R
Lenticulina munsteri	F	F	A
Lenticulina quenstedti		R	R
Lenticulina quenstedti var. B	R	R	F
Lenticulina subalata	C	F	
Lenticulina tricarinella	R		A
Lenticulina turgida	R		
Lingulina laevissima	R	R	
Marginulina terquemi	R		
Nodosaria hortensis	R	R	F
Nodosaria aff. N. issleri	R		R
Nodosaria opalini	R	R	
Nodosaria aff. N. prima		R	R
Patellina oolithica	F	F	
Planularia beierana	R	C	F
Planularia protracta	R	F	R
Pseudonodosaria pupoides		R	
Pseudonodosaria vulgata	R		
Spirillina infima	A	A	C
Trochammina haeusleri	R		
Vaginulina clathrata eypensa		R	A
Vaginulina contracta	C		R
Vaginulina sp.	R	R	R

Table 6. Foraminifera from the interval between the *Acuminata* Bed and the "Fuller's Earth Rock proper," Cross Ways Inn (Cox, 1941, p. 20).

Sample BCR1

Dentalina intorta	Rare
Dentalina propinqua	Rare
Flabellamina althoffi	Rare
Frondicularia nodosaria	Rare
Haplophragmium suprajurassicum	Common
Lenticulina munsteri	Common
Lenticulina quenstedti	Few
Lenticulina tricarinella	Abundant
Nodosaria subplana	Rare
Planularia beierana	Abundant
Pseudonodosaria pupoides	Rare
Spirillina infima	Few
Spirophthalmidium concentricum	Rare
Triplasia bartensteini	Common
Vaginulina clathrata eypensa	Common
Vaginulina sp. A	Rare

Table 7. Foraminifera from the Upper Fuller's Earth Clay, Combe Hay Fuller's Earth Works, Bath.

(Samples BCH1, BCH3, BCH4)

	1	2	3
Ammobaculites agglutinans			R
Ammobaculites fontinensis		R	
Anomalina liassica			R
Citharina heteropleura			R
Citharina sp. A		R	
Cornuspira liasina	C	A	C
Dentalina communis	R	R	F
Dentalina aff. D. communis	R		
Dentalina intorta	R	F	R
Dentalina propinqua		R	
Eoguttulina angustata	R	R	F
Eoguttulina liassica	F	C	F
Frondicularia involuta	R		
Frondicularia nodosaria	R		R
Lenticulina munsteri		F	R
Lenticulina subalata		R	
Lingulina dentaliniformis	R	R	R
Lingulina laevissima		R	
Marginulina terquemi			R
Nodosaria hortensis	R	R	
Nodosaria aff. N. issleri		R	
Nodosaria opalini	F	R	
Patellina oolithica			R
Planularia beierana	F	F	F
Pseudonodosaria hybrida	R		R
Spirillina infima	C	C	C
Spirophthalmidium concentricum	R	R	R
Trochammina haeusleri	F		R
Vaginulina contracta	A	A	C

Table 8. Foraminifera from the Upper Fuller's Earth Clay, Vernham Wood.

1—(BFW5) From middle of bed e
2—(BFW4) From clay band in bed d
3—(BFW2) From bottom of bed b
4—(BFW1) From top of bed b

	1	2	3	4
Dentalina communis		R		
Dentalina intorta	C	C		
Dentalina propinqua		R		
Eoguttulina angustata	R			
Eoguttulina liassica	C	C	F	
Haplophragmum suprajurassicum	R	F	R	R
Frondicularia involuta		R		R
Frondicularia spissa		R		
Lenticulina munsteri		C		R
Lenticulina subalata		F		
Lenticulina turgida?	R			
Lenticulina varians	C	R	A	F
Lingulina dolium			R	
Nodosaria hortensis		R	R	R
Nodosaria opalini		R	R	R
Patellina oolithica		F		
Planularia anceps			R	R
Planularia protracta	F	F		R
Pseudonodosaria pupoides		R		
Spirillina infima	A	A	A	A
Tristix suprajurassicum			R	
Triplasia bartensteini		F		F
Trochammina globigeriniformis	R			
Trochammina haeusleri		R	C	R
Vaginulina harpa	R			
Vaginulina legumen	F	A	A	F

Table 9. Foraminifera from the Upper Fuller's Earth Clay, Henley Hill, Box.

1—(Sample BC016) about 10 feet below contact of Great Oolite Limestones.
2—(Sample BC015) 2 feet below contact.

	1	2
Cornuspira liasina	C	A
Dentalina aff. D. communis	R	R
Dentalina intorta	C	F
Dentalina oolithica		R
Dentalina propinqua		R
Eoguttulina liassica	F	F
Frondicularia dentaliniformis		R
Frondicularia involuta	R	
Frondicularia nodosaria		C
Lenticulina munsteri	R	A
Lenticulina subalata	C	
Lenticulina tricarinella		R
Lenticulina turgida	R	F
Lingulina dolium	F	
Lingulina laevissima		F
Nodosaria hortensis		R
Nodosaria opalini	R	R
Planularia beierana	F	A
Planularia protracta		R
Pseudonodosaria hybrida		R
Pseudonodosaria pupoides	R	R
Saracenaria triquetra		R
Spirillina infima	F	F
Spirophthalmidium concentricum	R	F
Trochammina globigeriniformis		R
Trochammina haeusleri		C
Vaginulina harpa		R
Vaginulina sp. A	R	F

Table 10. Foraminifera from the Bradford Clay, Bradford-on-Avon.

1—(Sample BBC5) 1 ft. above fossil bed.
2—(Sample BBC4) 3 ft. above fossil bed.
3—(Sample BBC3) 5 ft. above fossil bed.
4—(Sample BBC1) 7 ft. above fossil bed.

	1	2	3	4
Ammobaculites agglutinans	A	A	R	R
Dentalina communis	R	R		
Dentalina aff. D. communis		R		R
Dentalina intorta	F	F	F	F
Dentalina oolithica	F	F	F	F
Dentalina propinqua	F	R	F	F
Dentalina subplana		R	R	R
Eoguttulina angustata		R		R
Eoguttulina liassica			R	F
Frondicularia dentaliniformis		R		
Frondicularia nodosaria	R			R
Frondicularia spissa				R
Lingulina dolium	R			
Lingulina laevissima		R	R	
Marginulina terquemi	R	R		
Massilina dorsetensis			R	C
Nodosaria hortensis		R		
Nodosaria opalini	R	R		F
Patellina oolithica		R		
Planularia beierana				R
Pseudonodosaria hybrida			R	
Pseudonodosaria vulgata				R
Spirillina infima	C	F	F	C
Spiroloculina lanceolata				C
Spirophthalmidium concentricum	R			F
Trochammina globigeriniformis	R			
Vaginulina contracta	R			R

Table 11. Foraminifera from the Forest Marble, Monk Quarry, Corsham.

1—(Sample BCO1) 38 ft. above Upper Rag Bed.
2—(Sample BCO2) 3 ft. above 1.
3—(Sample BCO3) 1 ft. above 2.
4—(Sample BCO5) 7 ft. above 3.
5—(Sample BCO6) 3½ ft. above 4.
6—(Sample BCO7) 3½ ft. above 5.
7—(Sample BCO8) 3 ft. above 6.
8—(Sample BCO9) 2 ft. above 7.

	1	2	3	4	5	6	7	8
Ammobaculites fontinensis				R				
Citharina heteropleura						R	R	
Cornuspira liasina	F	F						
Dentalina intorta		R	R			R		R
Dentalina oolithica			R					R
Discorbis dreheri								R
Eoguttulina angustata			R	F				
Eoguttulina liassica		F	F			F	F	R
Frondicularia involuta	R			R		R	R	F
Frondicularia nodosaria			R					
Haplophragmium suprajurassicum		R						
Lenticulina munsteri			F	A	A	A	A	C
Lenticulina varians	F	R					R	F
Nodosaria opalini		R			R	R	R	F
Patellina oolithica								R
Planularia anceps ?							R	
Planularia beierana								C
Pseudonodosaria pupoides	F		R	R	R			C
Reophax multilocularis		R	R					
Spirillina infima				R	R			
Spiroloculina lanceolata ?		R						
Tristix suprajurassicum								R
Trochammina globigeriniformis		R						
Trochammina haeusleri			R					
Vaginulina contracta				R				
Vaginulina legumen			R	C	R	R	A	C

Table 12. Foraminifera from the Great Oolite Limestones, Cirencester-Chedworth railway cuttings (Richardson, 1911a).

1—(Sample CTCH6) Taynton Stone, bed 36, about 10 ft. from top (Chedworth).

2—(Sample CTCH7) Taynton Stone, bed 36, about 5 ft. above 1 (Chedworth).

3—(Sample CTCH3) White Limestone, bed 19a (Stony Furlong).

4—(Sample CTCH2) White Limestone, bed 19 (Stony Furlong).

5—(Sample CTCH11) White Limestone, marl layer, about bed 16 (Aldgrove).

6—(Sample CTCH4) White Limestone, bed 14 or 15 (Stony Furlong).

7—(Sample CTCH8) White Limestone, base of bed 14 (Aldgrove).

8—(Sample CTCH12) White Limestone, bed 14, about 5 ft. above 9 (Aldgrove).

9—(Sample CTCH14) White Limestone, bed 8 (Folly Barn).

10—(Sample CTCH15) White Limestone bed 4 or 5 (Folly Barn).

	1	2	3	4	5	6	7	8	9	10
Ammobaculites agglutinans		R				R	R			
Ammobaculites fontinensis		R	R	F	F		F	F		R
Cornuspira liasina			C		F	C		F	C	
Dentalina intorta		F	R		F	R				R
Dentalina mucronata	F					R		R		
Dentalina propinqua	R								R	
Dentalina torta	F									
Discorbis dreheri						R				
Eoguttulina angustata	F	R								
Eoguttulina liassica	F	F	R			C		F	C	
Frondicularia dentaliniformis	R									
Frondicularia involuta										R
Frondicularia spissa								R		
Haplophragmium suprajurassicum		R			R	R	R			R
Lagena striata									R	
Lenticulina galeata					R		R	R		
Lenticulina multangulosa	R	R			R		R			
Lenticulina munsteri				R						F
Lenticulina subalata			R							
Lenticulina varians						R		R	R	

Lingulina dolium	F									
Lingulina sp. A	R	R								
Lingulina sp. C	F									
Marginulina terquemi					R		F	F		
Nodosaria hortensis									R	
Nodosaria aff. issleri						R				
Nodosaria opalini	R	R							R	R
Patellina oolithica			R			R	R			
Planularia anceps						R				
Planularia beierana					R					
Planularia breoni	R	R								
Planularia protracta							R			
Planularia sp. A									R	
Planularia sp. B								F	F	
Pseudonodosaria hybrida	A									
Spirillina infima	F					C	R	C	F	
Spiroloculina lanceolata		R					R			F
Triplasia bartensteini		R		R	R		R			F
Tristix suprajurassicum							R			R
Trochammina globigeriniformis						R				R
Vaginulina contracta		R	R	R			F	R	F	
Vaginulina legumen	R	F	R	A	F	C	F	R		
Vaginulina sp.					R	R				R

Table 13. Foraminifera from the Great Oolite Limestones, Hampen railway cuttings (Richardson, 1929, pp. 104-105).

1—(Sample CTH18) Stonesfield Slate Beds, about 22 ft. below top (probably bed 7b).

2—(Sample CTH17) Stonesfield Slate Beds, 4 ft. above 1.

3—(Sample CTH16) Stonesfield Slate Beds, 3 ft. above 2 (probably bed 6).

4—(Sample CTH14) Stonesfield Slate Beds, top of Stonesfield Slate Beds (*Rhynchonella* Bed).

5—(Sample CTH13) Taynton Stone, about 20 ft. below top.

6—(Sample CTH12) Taynton Stone, 5 ft. above 5.

7—(Sample CTH2) Hampen Marly Beds, about 10 ft. below top.

8—(Sample CTH1) Hampen Marly Beds, 2 ft. above 2.

	1	2	3	4	5	6	7	8
Ammobaculites agglutinans				R	R		R	
Cornuspira liasina	C	F		R			F	
Dentalina intorta	R	R	R				R	
Dentalina mucronata			R	R			R	
Eoguttulina angustata			R				R	
Eoguttulina liassica	C	F	A	C	R	F	R	
Flabellamina althoffi		R		F				
Frondicularia dentaliniformis	R		C	R				
Frondicularia involuta							F	F
Haplophragmium suprajurassicum		R		F	R		F	R
Lenticulina multangulosa						R		
Lenticulina munsteri		R		R				
Lenticulina quenstedti			F					
Lenticulina quenstedti var. B		F						
Lenticulina subalata			F				R	
Lenticulina turgida							R	
Lenticulina varians	R						A	A
Lingulina dolium	R		F					
Lingulina laevissima			F					
Nodosaria opalini				R				
Planularia anceps							R	
Planularia beierana			R					
Planularia protracta				R				
Planularia sp. A				R				
Pseudonodosaria hybrida			R	F				
Pseudonodosaria pupoides		R					R	R
Spirillina infima	F	F		R	R	R	C	R
Spiroloculina lanceolata						R		
Triplasia bartensteini						R	F	
Trochammina haeusleri			R					
Trochammina sp.							R	R
Vaginulina contracta							F	
Vaginulina legumen			R	F		R	F	C

Table 14. Foraminifera from Great Oolite Limestones, quarry at Salperton.

1—(Sample CTH9) White Limestone, about 2 ft. above base.
2—(Sample CTH8) Hampen Marly Beds, about 2 ft. below top.
3—(Sample CTH7) Hampen Marly Beds, about 4 ft. below top.

	1	2	3
Ammobaculites agglutinans			R
Ammobaculites fontinensis		R	R
Cornuspira liasina	F	F	
Dentalina intorta		R	
Dentalina mucronata		F	F
Dentalina torta		C	F
Discorbis dreheri			R
Eoguttulina liassica		R	C
Flabellamina althoffii	F		
Frondicularia dentaliniformis	R		
Globulina sp.			R
Lenticulina multangulosa			F
Lenticulina munsteri	R		R
Lenticulina quenstedti var. B ?		R	
Lenticulina subalata	C		
Lingulina dolium			R
Lingulina laevissima			R
Lingulina sp. A			R
Lingulina sp. C		R	
Nodosaria opalini		R	C
Nodosaria sp. B			R
Planularia beierana			R
Planularia eugenii		R	
Pseudonodosaria hybrida		R	R
Spirillina infima	R		
Triplasia bartensteini		R	R
Trochammina globigeriniformis			R
Trochammina haeusleri	F	R	
Vaginulina clathrata eypensa ?	R		
Vaginulina contracta	R	F	F
Vaginulina legumen	R		R

Table 15. Foraminifera from the Great Oolite, Kirtlington Cement Works, Kirtlington.

1—(Sample OXK4) White Limestone, 15 ft. below top.
2—(Sample OXK3) White Limestone, 1 ft. below top.
3—(Sample OXK9) Kemble Beds, 1 ft. below top.
4—(Sample OXK8) Wychwood Beds, 4 ft. below top.
5—(Sample OXK7) Wychwood Beds, ½ ft. below top.

	1	2	3	4	5	6
Cornuspira liasina	R	R	R	F	F	R
Dentalina cf. D. bicornis				R		
Dentalina communis				R		
Dentalina intorta		R	F	F	R	F
Dentalina mucronata		F	R			
Dentalina oolithica			R	C		R
Dentalina propinqua		R	R			
Eoguttulina angustata				R		
Eoguttulina liassica		F	R	C	R	R
Frondicularia nodosaria			F			
Frondicularia spissa			F	C		
Haplophragmium suprajurassicum	R		R			
Lagena striata						R
Lenticulina munsteri			F		R	
Lenticulina subalata			F		R	
Lingulina laevissima			R			R
Lingulina sp. B				R		
Nodosaria hortensis			C	R		
Nodosaria opalini		R	F	R		R
Nodosaria pectinata				R		
Nodosaria plicatilis			R			
Patellina oolithica				R	R	
Pseudonodosaria hybrida			R			
Pseudonodosaria pupoides			R			
Spirillina infima	C	F	R	C	A	A
Spirophthalmidium concentricum			C	R		
Vaginulina contracta			R	C		
Vaginulina legumen	C		R	R		
Vaginulina sp. A			R			

Table 16. Foraminifera from Sharp's Hill Beds, Sharp's Hill Quarry.

1—(Sample OXS5) Lower Sharp's Hill Beds, about 5 ft. below top.
2—(Sample OXS2) Top of Lower Sharp's Hill Beds.
3—(Sample OXS3) Upper Sharp's Hill Beds, about 3 ft. from top.
4—(Sample OXS4) Upper Sharp's Hill Beds, ½ ft. from top.

	1	2	3	4
Cornuspira liasina	F	F		F
Dentalina communis				R
Dentalina conferta		R		
Dentalina cf. D. communis	R			
Dentalina intorta	F	F	F	F
Dentalina oolithica		R	R	
Eoguttulina angustata	R			R
Eoguttulina liassica		R	R	
Epistomina stelligera				R
Frondicularia dentaliniformis		R		
Frondicularia involuta	R	R		
Haplophragmium suprajurassicum	R	R	R	R
Lagena striata		R		
Lenticulina munsteri	A	C		
Lingulina sp. A		R		
Trochammina haeusleri		R		
Nodosaria hortensis		R		
Nodosaria opalini	R	F	R	F
Nodosaria sp. A	R			
Paleopolymorphina pleurostomelloides		R		
Patellina oolithica	R			
Planularia sp. B		F		
Pseudonodosaria hybrida	R			
Spirillina infima	F	C	C	C
Spirophthalmidium concentricum	R	C	A	F
Vaginulina contracta		F	R	
Vaginulina legumen	C	R		F

Table 17. Foraminifera from the Upper Estuarine Beds, Clipsham New Quarry, Rutland.

1—(Sample RuC6) Upper Estuarine Beds about 16 ft. below top, in "*Astarte fimbriata*" Beds.

2—(Sample RuC3) Upper Estuarine Beds, about 8ft. above 1.

3—(Sample RuC2) Upper Estuarine Beds, about 3½ ft. below top.

4—(Sample RuC1) Upper Estuarine Beds, immediately below Great Oolite Limestone.

	1	2	3	4
Cornuspira liasina	F	F		
Eoguttulina angustata	R	F		
Eoguttulina liassica	F	A	A	A
Frondicularia spissa		R		
Haplophragmium suprajurassicum		R		
Lingulina laevissima		R		
Nodosaria opalini		F		
Pseudonodosaria hybrida		R		
Spirillina infima	A	C		
Thurammina tuberosa	R	C		

Table 18. Foraminifera from the Upper Estuarine Beds, Twywell Ironstone Pit.

1—(Sample NHT3) Upper Estuarine Beds, about 9 ft. below top.
2—(Sample NHT2) Upper Estuarine Beds, 4 ft. below top.
3—(Sample NHT0) Upper Estuarine Beds, 2 ft. below top.
4—(Sample NHT7) Upper Estuarine Beds, immediately below top.

	1	2	3	4
Ammobaculites fontinensis			R	
Dentalina intorta				F
Dentalina oolithica				R
Eoguttulina liassica	A		R	
Globulina sp.		R		R
Haplophragmium suprajurassicum		R		
Lagena striata				R
Lenticulina subalata		F	A	
Lenticulina varians		F	R	A
Nodosaria opalini	C			
Planularia sp. B			R	
Pseudonodosaria hybrida			R	R
Spirillina infima			R	R
Spiroloculina lanceolata ?	R			
Vaginulina contracta			R	R
Vaginulina legumen			F	R

Index of generic and specific names

PLATES

PLATE 1

Except where specified, all figures are × 60

1 *Ammobaculites agglutinans* (d'Orbigny): Bradford Clay, Bath area (BBC5). MCZ No. 3304.

2-5 *Ammobaculites fontinensis* (Terquem).
2—Hampen Marly Beds, Cotswolds (CTH7). MCZ No. 3305A.
3, 4—Upper Fuller's Earth Clay, Dorset, (DoC4). MCZ No. 3305B.
5—Upper Estuarine Beds, Northamptonshire (NTHO). MCZ No. 3305C.

6-7 *Reophax multilocularis* Haeusler.
6—Upper Fuller's Earth Clay, Dorset (DoC10). MCZ No. 3302A.
7—*Elongata* Beds, Dorset (DoH1). MCZ No. 3302B.

8 ?*Problematina* cf. *P. liassica* (Jones). *Elongata* Beds, Dorset (DoH1). MCZ No. 3308.

9-10 *Haplophragmium suprajurassicum* Schwager.
9—*Wattonensis* Beds, Dorset (DoEM1). MCZ No. 3309A.
10—Cross Ways Inn section, near Bath (BCR1). MCZ No. 3309B.

11 *Triplasia bartensteini* Loeblich and Tappan; Cross Ways Inn section, near Bath (BCR1). MCZ No. 3310.

12-14 *Spirophthalmidium concentricum* (Terquem and Berthelin); Upper Fuller's Earth Clay, Dorset (DoC5). MCZ No. 3314.

15-17 *Massilina dorsetensis* n. sp.; Forest Marble, Dorset (DoWA).
15, 16—Paratypes. MCZ No. 3311A.
17—Holotype. MCZ No. 3311B.

18-19 *Spiroloculina lanceolata* (Terquem and Berthelin); Upper Fuller's Earth Clay, Dorset (DoW1). MCZ No. 3312.

20 *Trochammina* sp.; Hampen Marly Beds, Cotswolds (CTH1). MCZ No. 3317.

21-22 *Trochammina haeusleri* (Galloway); Upper Fuller's Earth Clay, Box (BCo16); × 100. MCZ No. 3315.

23-24 *Trochammina globigeriniformis* (Parker and Jones).
23—*Wattonensis* Beds, Dorset (DoEm2). MCZ No. 3316A.
24—Upper Fuller's Earth Clay, Bath area (BC016). MCZ No. 3316B.

25-26 *Flabellamina althoffi* Bartenstein.
25—Cross Ways Inn section, Bath area (BCR1). MCZ No. 3303A.
26—Upper Fuller's Earth Clay, Dorset (DoC4). MCZ No. 3303B.

27-28 *Cornuspira liasina* Terquem; Forest Marble, Dorset (DoWF). MCZ No. 3313.

29 *Thurammina tuberosa* Haeusler; Upper Estuarine Beds, Rutland, (RuC3). MCZ No. 3301.

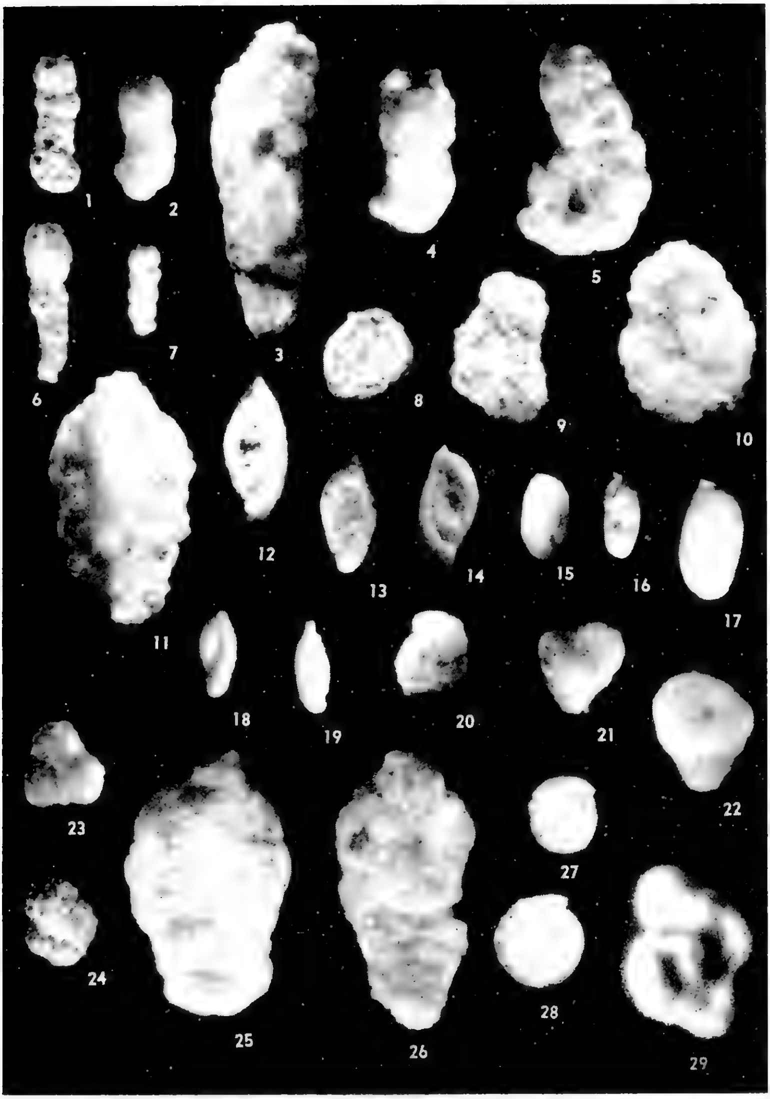

PLATE 1

PLATE 2

Except where specified, all figures are × 60

1-2 *Lenticulina subalata* (Reuss); Upper Fuller's Earth Clay, Dorset (DoC5). MCZ No. 3324.

3-5 *Lenticulina mwnsteri* (Roemer); Upper Fuller's Earth Clay, Dorset (DoC5). MCZ No. 3320.

6-7 *Lenticulina quenstedti* (Gumbel); *Wattonensis* Beds, Dorset (DoEm1). MCZ No. 3321.

8 *Lenticulina quenstedti* var. B n.var.; *Wattonensis* Beds, Dorset (DoEm1). MCZ No. 3323.

9-10 *Lenticulina quenstedti* var. A n.var.
9—Lower Fuller's Earth Clay, Dorset (DoBu4). MCZ No. 3322A.
10—Lower Fuller's Earth Clay, Bath area (BMF1). MCZ No. 3322B.

11-13 *Lenticulina varians* (Borneman).
11—Hampen Marly Beds, Cotswolds (CTH2). MCZ No. 3328A.
12, 13—Forest Marble, Dorset (DoWA). MCZ No. 3328B.

14 *Lenticulina multangulosa* (Schwager); Hampen Marly Beds, Cotswolds (CTH7). MCZ No. 3319.

15-17 *Lenticulina galeata* (Terquem); Lower Fuller's Earth Clay, Dorset (DoBu5). MCZ No. 3318.

18-19 *Lenticulina turgida* (Schwager); *Wattonensis* Beds, Dorset (DoEm4). MCZ No. 3329.

20-23 *Lenticulina tricarinella* (Reuss); Fuller's Earth Rock, Bath area (BaM4). MCZ No. 3326.

24 *Lenticulina tricarinella* var. A n.var.; Upper Fuller's Earth Clay, Dorset (DoC5). MCZ No. 3327.

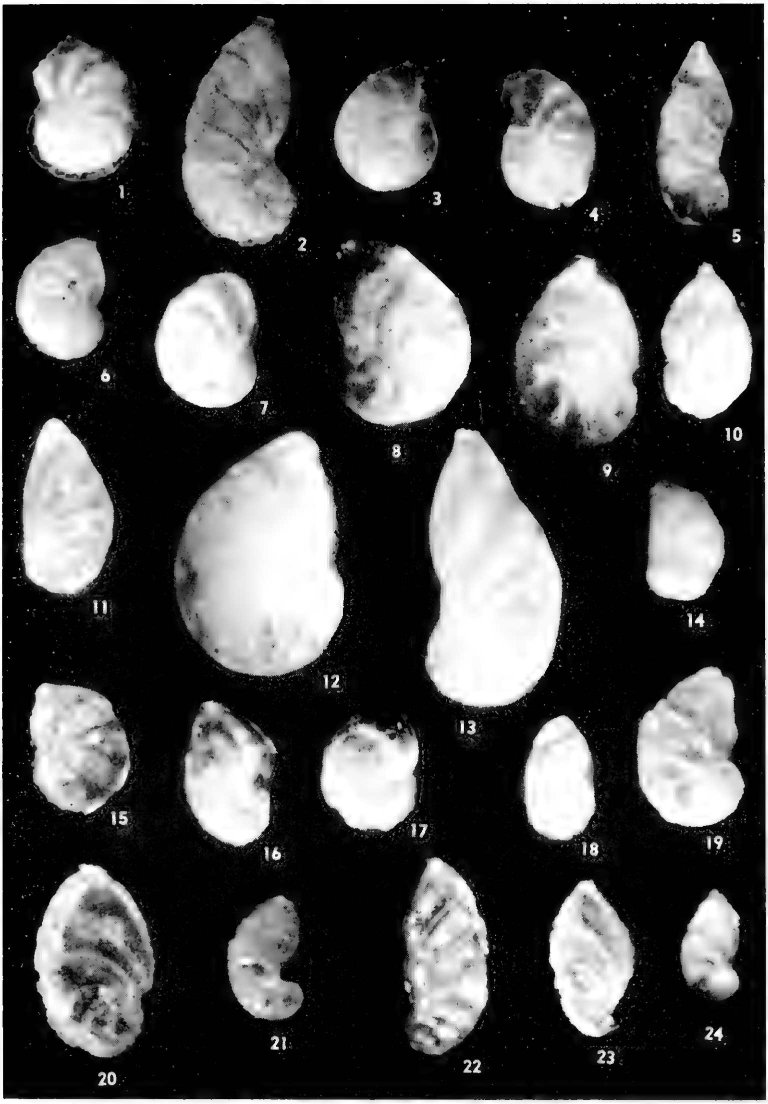

PLATE 2

PLATE 3

Except where specified, all figures are × 60

1-10 *Planularia beierana* (Gumbel).

1, 4, 6, 7, 10—*Wattonensis* Beds, Dorset (DoEm4). MCZ No. 3330A.

2—Upper Fuller's Earth Clay, Dorset (DoC2). MCZ No. 3330B.

3—*Wattonensis* Beds, Dorset (DoEm1). MCZ No. 3330C.

5—*Wattonensis* Beds, Dorset (DoEm0). MCZ No. 3330D.

8, 9—Lower Fuller's Earth Clay?, Bath area (BCO14). MCZ No. 3330E.

11 *Planularia breoni* (Terquem); Hampen Marly Beds, Cotswolds (CTH7). MCZ No. 3331.

12-13 *Planularia protracta* (Borneman).

12—Upper Fuller's Earth Clay, Bath area (BFW4). MCZ No. 3334B.

13—*Wattonensis* Beds, Dorset (DoEm3). MCZ No. 3334A.

14-15 *Planularia anceps* (Terquem); *Wattonensis* Beds, Dorset (DoEm4). MCZ No. 3329.

14—Megalosphere.

15—Microsphere.

16-17 *Planularia eugenii* (Terquem).

16—*Wattonensis* Beds, Dorset (DoEm4). MCZ No. 3332A.

17—Lower Fuller's Earth Clay, Dorset (DoBu2). MCZ No. 3332B.

18 *Planularia* sp. B; White Limestone, Cotswolds (CTCH12). MCZ No. 3336.

19-20 *Marginulina terquemi* d'Orbigny; Upper Fuller's Earth Clay, Dorset (DoC5). MCZ No. 3338.

21 *Marginulina deslongchampsi* Terquem; Lower Fuller's Earth Clay, Dorset (DoBu4). MCZ No. 3337.

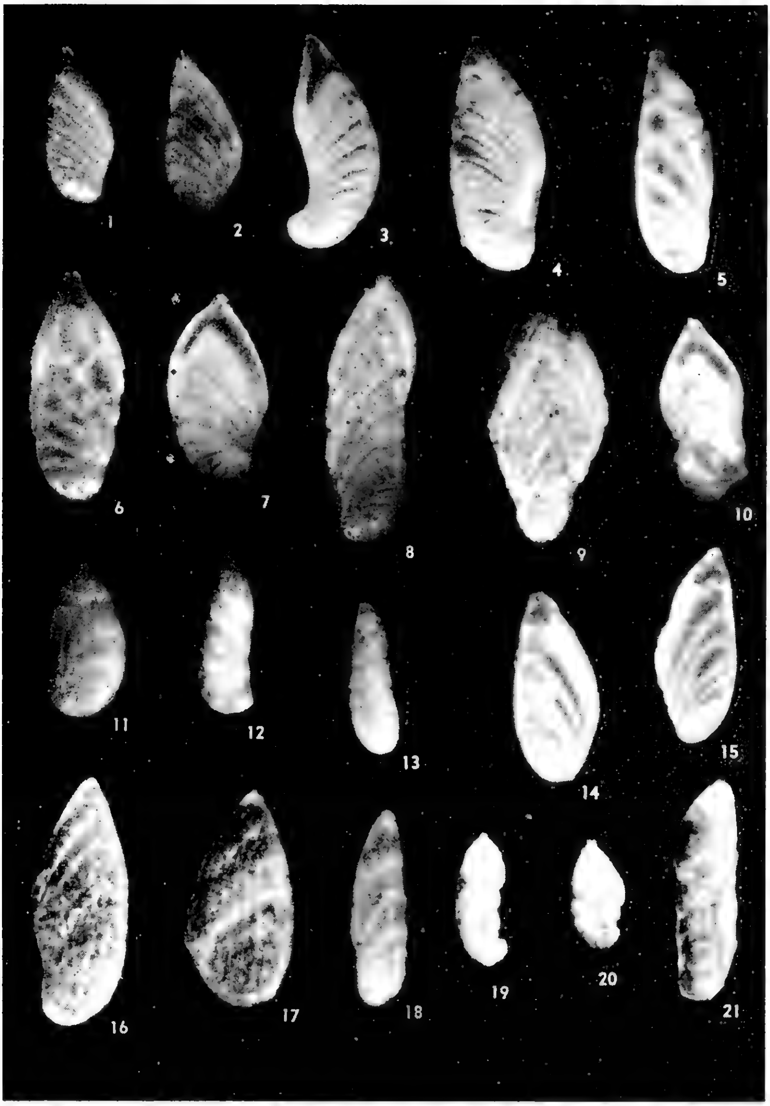

PLATE 3

PLATE 4

Except where specified, all figures are × 60

1-2 *Dentalina mucronata* Neugeboren.
1—Forest Marble, Dorset (DoWD). MCZ No. 3344A.
2—Upper Fuller's Earth Clay, Dorset (DoC5). MCZ No. 3344B.

3 *Dentalina conferta* Schwager; *Wattonensis* Beds, Dorset (DoEm1); × 100. MCZ No. 3342.

4-6 *Dentalina propinqua* Terquem; Upper Fuller's Earth Clay, Dorset (DoW1); Figure 6× 100. MCZ Nos. 3347A, 3347B, 3347C, 3347D.

7 *Dentalina bicornis* Terquem; Wychwood Beds, Oxfordshire (OXK9). MCZ No. 3339.

8 *Dentalina nodigera* Terquem and Berthelin; *Wattonensis* Beds, Dorset (DoEm6). MCZ No. 3345.

9 *Dentalina torta* Terquem; Hampen Marly Beds, Cotswolds (CTH7). MCZ No. 3349.

10 *Dentalina oolithica* Terquem; Upper Fuller's Earth Clay, Dorset (DoC1); × 100. MCZ No. 3346.

11 *Dentalina communis* d'Orbigny; Wychwood Beds, Oxfordshire (OXK9); × 25. MCZ No. 3340A.

12-13 *Dentalina subplana* Terquem; *Wattonensis* Beds, Dorset (DoEm4). MCZ Nos. 3348A, 3348B, 3348C.

14-15 *Dentalina* aff. *D. communis* d'Orbigny; Forest Marble, Dorset (DoWG). MCZ Nos. 3341A, 3341B.

16-19 *Dentalina intorta* Terquem.
16, 17—Forest Marble, Dorset (DoWB). MCZ 3343A, 3343B.
18—Upper Fuller's Earth Clay, Dorset (DoC1). MCZ No. 3343C.
19—Forest Marble, Dorset (DoWB); × 100. MCZ No. 3343D.

20 *Nodosaria clavula* Terquem; Forest Marble, Dorset (DoWB). MCZ No. 3350.

21 *Nodosaria plicatilis* Wisniowski; *Wattonensis* Beds, Dorset (DoEm0). MCZ No. 3356.

22-24 *Nodosaria hortensis* Terquem.
22—Upper Fuller's Earth Clay, Dorset (DoC5). MCZ No. 3351A.
23—Lower Fuller's Earth Clay, Dorset (DoBu2). MCZ No. 3351B.
24—Lower Fuller's Earth Clay, Dorset (DoBu3). MCZ No. 3351C.

25 *Nodosaria ingens* (Terquem); *Wattonensis* Beds, Dorset (DoEm6); × 100. MCZ No. 3352A.

26-31 *Nodosaria opalini* Bartenstein; Upper Fuller's Earth Clay, Dorset (DoC2). MCZ No. 3354.

32 *Nodosaria* aff. *N. prima* d'Orbigny; Lower Fuller's Earth Clay, Bath area (BaM1). MCZ No. 3357.

33 *Nodosaria liassica* (Barnard); Lower Fuller's Earth Clay, Dorset (DoBu5). MCZ No. 3353.

34-35 *Nodosaria pectinata* (Terquem).
34—Upper Fuller's Earth Clay, Dorset (DoC8). MCZ No. 3355A.
35—Upper Fuller's Earth Clay, Dorset (DoC5). MCZ No. 3355B.

36-37 *Nodosaria* aff. *N. issleri* Franke; Upper Fuller's Earth Clay, Bath area (BCH3). MCZ No. 3352B.

38 *Nodosaria* sp. A; Sharp's Hill Beds, Oxfordshire (OXS5). MCZ No. 3358.

39 *Nodosaria* sp. B; Hampen Marly Beds, Cotswolds (CTH7). MCZ No. 3359.

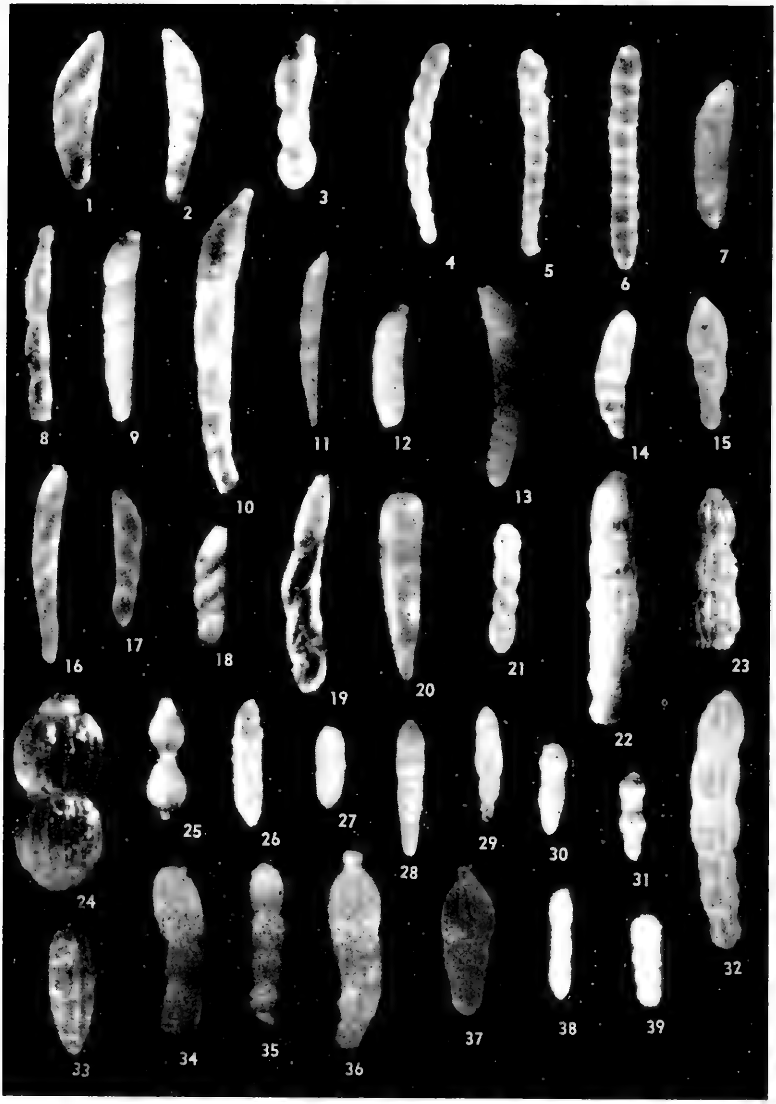
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PLATE I

PLATE 5

Except where specified, all figures are × 60

1-2 *Pseudonodosaria oviformis* (Terquem); Lower Fuller's Earth Clay, Dorset (DoBu1). MCZ No. 3363.

3 *Pseudonodosaria vulgata* (Borneman); Upper Fuller's Earth Clay, Dorset (DoC2). MCZ No. 3361.

4-6 *Pseudonodosaria pupoides* (Borneman).
4, 5—Forest Marble, Bath area (BCO9). MCZ 3364A.
6—Forest Marble, Bath area (BCO1). MCZ No. 3364B.

7-11 *Pseudonodosaria hybrida* (Terquem and Berthelin).
7—Upper Fuller's Earth Clay, Dorset (DoW1). MCZ No. 3362A.
8—Upper Fuller's Earth Clay, Dorset (DoC4). MCZ No. 3362B.
9, 11—Hampen Marly Beds, Cotswolds (CTH7). MCZ No. 3362C.

12 *Tristix suprajurassicum* (Paalzow); *Wattonensis* Beds, Dorset (DoEm1). MCZ No. 3360.

13 *Vaginulina macilenta* (Terquem); Lower Fuller's Earth Clay, Dorset (DoBu5). MCZ No. 3371.

14 *Vaginulina* cf. *V. hechti* Bartenstein; *Wattonensis* Beds, Dorset (DoEm4). MCZ No. 3369.

15-16 *Vaginulina legumen* (Linné); Forest Marble, Bath area (BCO8). MCZ No. 3370A.

17 *Vaginulina contracta* (Terquem); Forest Marble, Bath area (BCO5). MCZ No. 3367.

18-19 *Vaginulina harpa* Roemer.
18—*Wattonensis* Beds, Dorset (DoEm0). MCZ No. 3368A.
19—Upper Fuller's Earth Clay, Bath area (BCH1). MCZ No. 3368B.

20-22 *Vaginulina clathrata* (Terquem); Lower Fuller's Earth Clay, Dorset (DoBu5). MCZ No. 3365A.

23-26 *Vaginulina clathrata eypensa* n. subsp.
23, 24, Paratypes Lower Fuller's Earth Clay?, Bath area (BC012). MCZ No. 3366A.
25, Paratype *Wattonensis* Beds, Dorset (DoEm1). MCZ No. 3366B.
26, Holotype Cross Ways Inn section, Bath area (BCR1). MCZ No. 3366C.

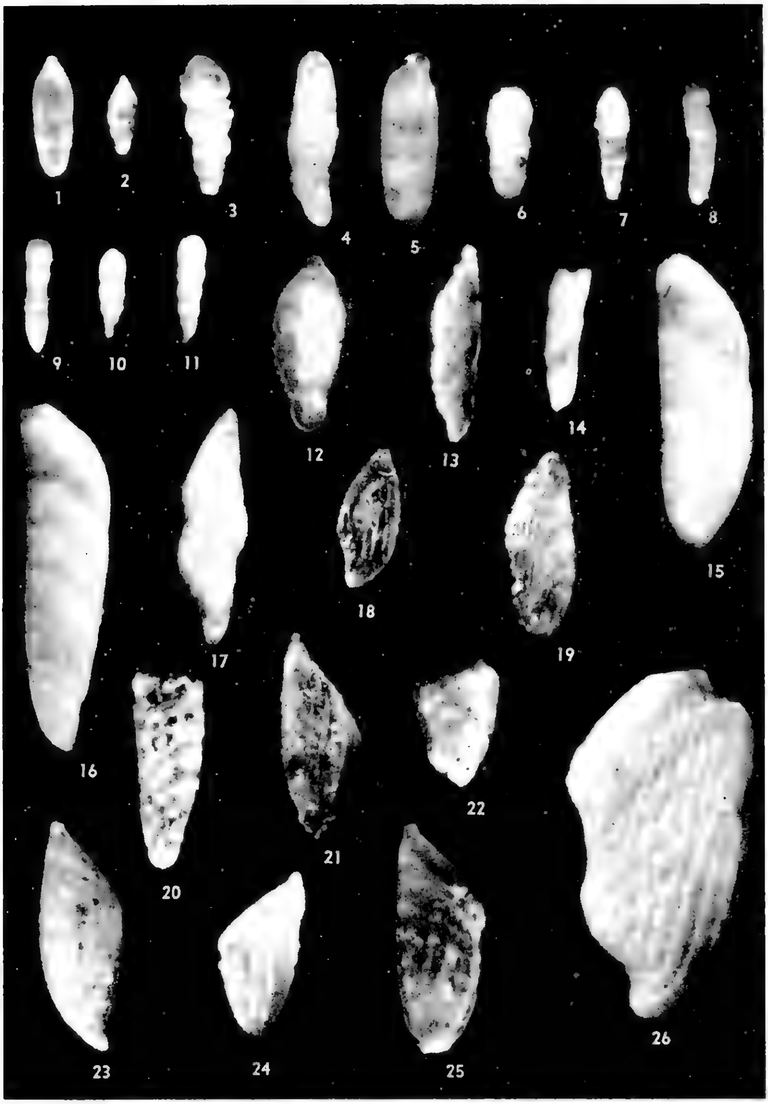

PLATE 5

PLATE 6

Except where specified, all figures are × 60

1-2 *Citharina colliezi* (Terquem).

1—*Wattonensis* Beds, Dorset (DoEm0); × 35. MCZ No. 3373A.

2—*Wattonensis* Beds, Dorset (DoEm1). MCZ No. 3373B.

3 *Citharina* sp.; *Wattonensis* Beds, Dorset (DoEm0); × 35. MCZ No. 3375C.

4-5 *Citharina heteropleura* (Terquem).

4—Upper Fuller's Earth Clay, Dorset (DoC5); × 100. MCZ No. 3374A.

5—Upper Fuller's Earth Clay, Dorset (DoC2). MCZ No. 3374B.

6-8 *Lingulina laevissima* (Terquem).

6—Upper Fuller's Earth Clay, Dorset (DoW1). MCZ No. 3378A.

7—Hampen Marly Beds, Cotswolds (CTH7); × 100. MCZ No. 3378B.

8—Upper Fuller's Earth Clay, Dorset (DoW1); × 100. MCZ No. 3378C.

9-10 *Lingulina dolium* (Terquem); Upper Fuller's Earth Clay, Bath area (BC015); Figure 9 × 100. MCZ No. 3377.

11-12 *Lingulina dentaliniformis* Terquem; Upper Fuller's Earth Clay, Dorset, (DoC5). MCZ No. 3376.

13 *Frondicularia intumescens* Borneman; Forest Marble, Dorset (DoWB); × 100. MCZ No. 3384.

14 *Lingulina* sp. B; Wychwood Beds, Oxfordshire (OXK9). MCZ No. 3380.

15 *Lingulina* sp. A; Hampen Marly Beds, Cotswolds (CTH7); × 100. MCZ No. 3379.

16 *Lingulina* sp. C; Hampen Marly Beds, Cotswolds (CTH7); × 100. MCZ No. 3381.

17-19 *Frondicularia dentaliniformis* Terquem.

17, 19—Hampen Marly Beds, Cotswolds (CTH7). MCZ No. 3382A.

18—Upper Fuller's Earth Clay, Dorset (DoC5). MCZ No. 3382B.

20-21 *Frondicularia lignaria* Terquem; Lower Fuller's Earth Clay, Dorset (DoBu4). MCZ No. 3385.

22-24 *Frondicularia spissa* Terquem.

22, 24—Forest Marble, Dorset (DoWG); × 100, MCZ No. 3388A.

23—Kemble Beds, Oxfordshire (OXK1). MCZ No. 3388B.

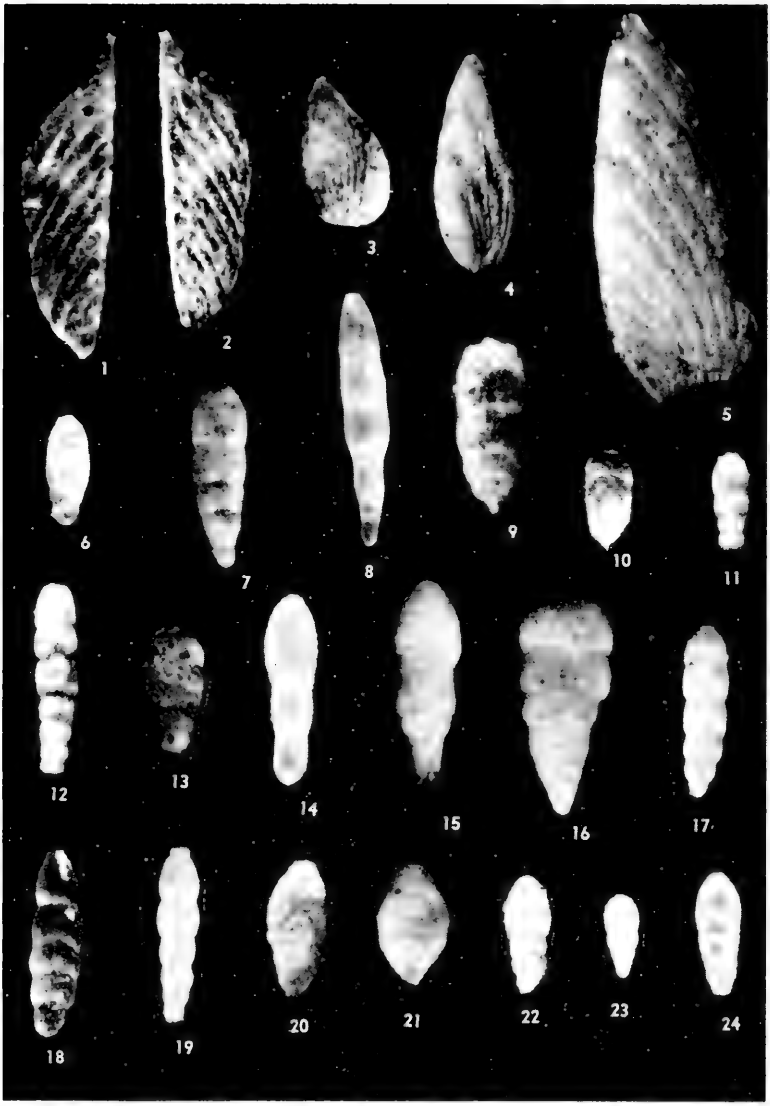

PLATE 6

PLATE 7

Except where specified, all figures are × 60

1-3 *Frondicularia involuta* Terquem.
1—Forest Marble, Bath area (BCO8). MCZ No. 3383A.
2—Forest Marble, Bath area (BCO9). MCZ No. 3383B.
3—Hampen Marly Beds, Cotswolds (CTH2). MCZ No. 3383C.

4-6 *Frondicularia nodosaria* Terquem.
4, 6—Upper Fuller's Earth Clay, Dorset (DoC7). MCZ No. 3386A.
5—*Wattonensis* Beds, Dorset (DoEm3). MCZ No. 3386B.

7-8 *Frondicularia nodosaria* Terquem var. A n.var.; Lower Fuller's Earth Clay, Dorset (DoBu4). MCZ No. 3387.

9-11 *Eoguttulina liassica* (Strickland).
9, 11—Upper Fuller's Earth Clay, Dorset (DoC5); × 100. MCZ No. 3393A.
10—Hampen Marly Beds (CTH7); × 100. MCZ No. 3393B.

12 *Eoguttulina angustata* (Terquem); Upper Estuarine Beds, Rutland (RuC3); × 100. MCZ No. 3392.

13 *Paleopolymorphina pleurostomelloides* (Franke); Sharp's Hill Beds, Oxfordshire, (OXS2); × 100. MCZ No. 3394.

14 *Globulina* sp.; Hampen Marly Beds, Cotswolds (CTH7); × 100. MCZ No. 3395.

15 *Bolivina rhumbleri* Franke; *Wattonensis* Beds, Dorset (DoEm4); × 100. MCZ No. 3397.

16 *Plectofrondicularia paradoxa* (Berthelin); Lower Fuller's Earth Clay, Bath area (BMF1); × 100. MCZ No. 3396.

17-20 *Epistomina stelligera* (Reuss); Upper Fuller's Earth Clay, Dorset (DoC6); × 100. MCZ No. 3400.

21-22 *Patellina oolithica* Terquem; Forest Marble, Dorset (DoWE). MCZ No. 3398B.
21—Ventral view; × 100.
22—Dorsal view; × 100.

23-25 *Discorbis dreheri* Bartenstein.
23—White Limestone, Cotswolds (CTCH4); dorsal view; × 100. MCZ No. 3399A.
24—White Limestone, Cotswolds (CTCH4); ventral view; × 100. MCZ No. 3399A.
25—*Wattonensis* Beds, Dorset (DoEm7); dorsal view; × 100. MCZ No. 3399B.

26 *Anomalina liassica* Issler; Upper Fuller's Earth Clay, Bath area (BCH4); × 100. MCZ No. 3401.

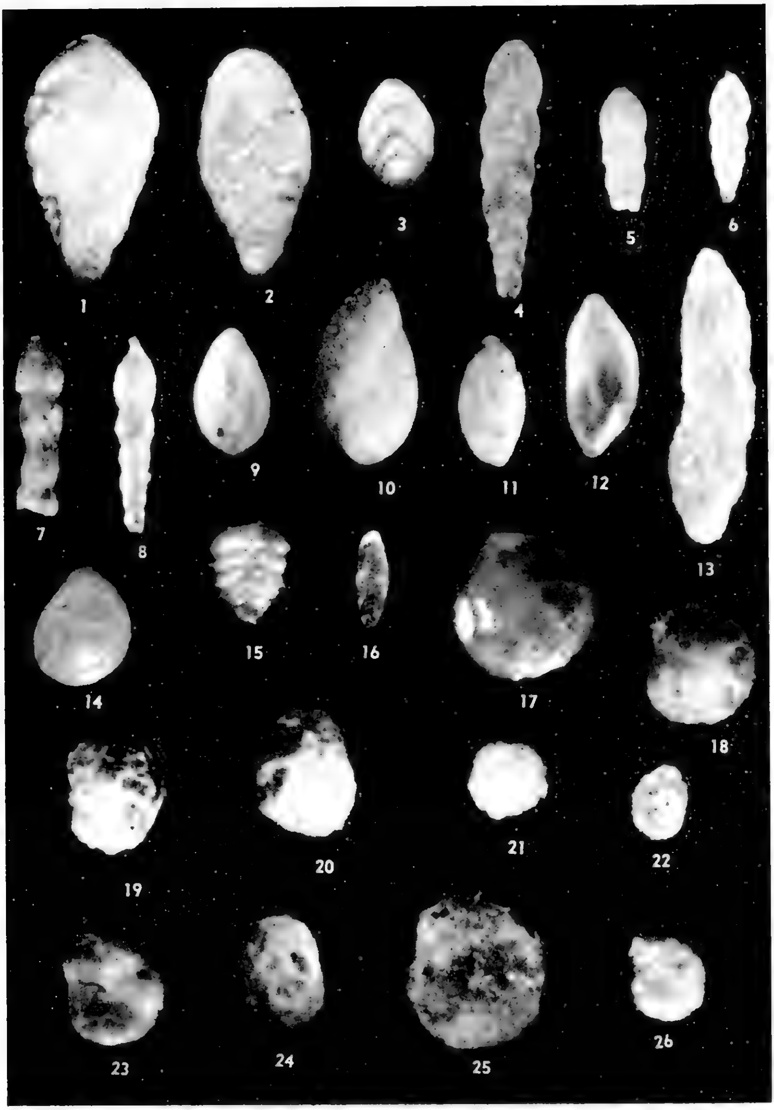

PLATE 7

Bulletin of the Museum of Comparative Zoology
AT HARVARD COLLEGE
Vol. 121, No. 8

SILICIFIED MIDDLE ORDOVICIAN TRILOBITES:

Remopleurididae, Trinucleidae, Raphiophoridae, Endymioniidae

By H. B. Whittington

With 36 Plates

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
November, 1959

PUBLICATIONS ISSUED BY OR IN CONNECTION WITH THE

MUSEUM OF COMPARATIVE ZOOLOGY
AT HARVARD COLLEGE

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BREVIORA (octavo) 1952 — No. 115 is current.

MEMOIRS (quarto) 1864–1938 — Publication was terminated with Vol. 55.

JOHNSONIA (quarto) 1941 — A publication of the Department of Mollusks. Vol. 3, no. 39 is current.

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No. 8—*Silicified Middle Ordovician Trilobites: Remopleurididae, Trinucleidae, Raphiophoridae, Endymioniidae*

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INTRODUCTION AND ACKNOWLEDGEMENTS

In these pages a further portion of the remarkable silicified material from Virginia is described. Lists give the stratigraphical distribution of all the trilobites from the Middle Ordovician of Virginia so far studied. From these lists support is derived for the correlation and classification of Middle Ordovican rocks recently proposed by G. Arthur Cooper. The species of *Raymondella* and *Salteria* described here are the only ones known other than the type species from Scotland, a striking example of the close similarities between some twelve species in the lower Edinburg formation and species of the same age in northwestern Europe. The rocks in each region also contain species of genera not known in the other.

Of the families here dealt with, this is the best preserved material so far known of both mature and developmental stages of the exoskeleton. The protaspis of a remopleuridid from older rocks had previously been described by Ross. The protaspides of five different species of *Remopleurides* are described here, and show a likeness to each other and to the older one. The species of *Remopleurides* occur through some 500-900 feet of limestone in Virginia, about 75 feet separating the Upper Lincolnshire and earliest lower Edinburg occurrences, and perhaps 350 feet separating the latest lower Edinburg and lower Martinsburg trilobite-bearing layers. A continuous record of an evolving series of forms is thus not available, but rather the collections reveal the appearance of new species at different levels and their disappearance at various times. There are two pairs of distinct but closely similar species, one pair comprising *R. asperulus* and *R. eximius* in the upper Lincolnshire and lower Edinburg, the other including *R. caelatus* and *R. plaesiourus* in the lower Edinburg and lower Martinsburg respectively. The pairs are quite dissimilar, and unlike either of the two additional species in the lower Edinburg. Morphological characters common to *Remopleurides* are differently developed in these and in other species — the great morphological detail revealed by the present material suggests the broad limits to the genus here drawn, but blurs distinctions which I might earlier have made (Whittington, 1950b, p. 542) between groups of species. The species of *Robergia* is like other species in this country and northwestern Europe; a few developmental stages are described. *Robergiella* n. gen. is based on fragmentary material, and displays characters intermediate between *Remopleurides* and *Robergia.*

Meraspid developmental stages of trinucleids have been described by several authors, but the present material includes the protaspis of two genera. The new species of *Tretaspis* is closely related to species of the same age from New York and Quebec, and to a younger species from Norway. The development of a raphiophorid was hitherto unknown. The development of four species, each belonging to a different genus, is here described and in one the series begins with the protaspis. The latter, and early meraspides, are like those of trinucleids, and display alae. A close relationship between these two families is thus suggested.

The history of the discovery of these fossils, and my reasons for being indebted to Dr. G. Arthur Cooper of the U. S. National Museum, have been recounted (Whittington, 1956, p. 160). Material collected and prepared by Dr. and Mrs. William R. Evitt has been used in these studies. I am indebted to Dr. Evitt for allowing me to use prints from his negatives, and to Mrs. Evitt for her painstaking sorting of the finest residues. Dr. Ethel D. Currie, Hunterian Museum, Glasgow, kindly loaned the original material of *Ampyxina aldonensis,* and Dr. G. Arthur Cooper allowed me to study the types of *Ampyxina powelli.* I am grateful also to Mrs. Karl Schuele, and to Mr. Ira B. Laby for preparing the enlargements from my negatives and for aiding in mounting the plates. The expenses of this assistance have been defrayed by a generous grant from the Permanent Science Fund of the American Academy of Arts and Sciences. Text-figure 6 was drawn from my sketches by Mr. F. Y. Cheng, and the remaining figures by Miss Margaret Estey.

TERMINOLOGY

The terminology used here is the same as that employed in previous descriptions (Whittington and Evitt, 1954, pp. 11-14; Whittington, 1956, pp. 160-162; Whittington, 1957, p. 423, fig. 1). Since trilobites are bilaterally symmetrical animals, many features of the exoskeleton are paired. Such paired structures have in most cases been described in the singular. When stating that a certain feature appears at "one-third the length" of a part of an exoskeleton, this distance is measured from the anterior end. *Sagittal* (sag.), *Exsagittal* (exs.), and *Transverse* (tr.) refer respectively to the median line, a line parallel to, but outside of the median, and a direction at right angles to the median.

The abbreviations used in the text are given in parentheses. The use of certain other terms may be explained as follows: —

Trinucleidae and Raphiophoridae

Occiput (Stäuble, 1953, p. 87) is applied to the slightly swollen glabellar ring situated between the occipital furrow and the basal lateral muscle area.

Fringe of trinucleids is described using terms devised for harpids by Whittington (1950a). Whittard (1955, pp. 27-29) has introduced a more precise notation for the pits of the fringe. I have followed him in numbering radial rows of pits "R", starting with R_1 which occurs just to the right of the midline and counting outward in arabic numbers towards the posterolateral part of the fringe.

Pygidium of both raphiophorids and trinucleids has the pleural regions extending horizontally outward and distally bent sharply down so that a narrow portion forms an almost vertically sloping *border*. At the point of flexure of the pleural regions there may be a narrow sharp ridge, here termed the *rim*. The external margin of the border is characteristically sinuous in outline with a broad *median notch*.

Remopleurididae

Some terms used in describing the cephalon are summarized in Text-figure 1.

Glabella. Used here to include the occipital ring, the area enclosed by the palpebral furrows (here termed the median glabellar area), and the glabellar tongue which lies between the anterior ends of the eye lobes; bounded laterally by the axial furrows and anteriorly by the preglabellar furrow. The narrow strip enclosed between the axial furrow and the anterior branch of the facial suture is referred to as the anterior area of the fixed cheek and that in front of the preglabellar furrow as the preglabellar area. *Palpebral rim* and *palpebral furrow* are used in the sense of Ross (1948, p. 574). The narrow wedge-shaped portion of the fixed cheek lying behind the eye lobe and outside the axial furrow is referred to as the posterior area of the fixed cheek. The narrow raised ridge that runs along the outer margin of the eye lobe, on the free cheek, was termed by Warburg

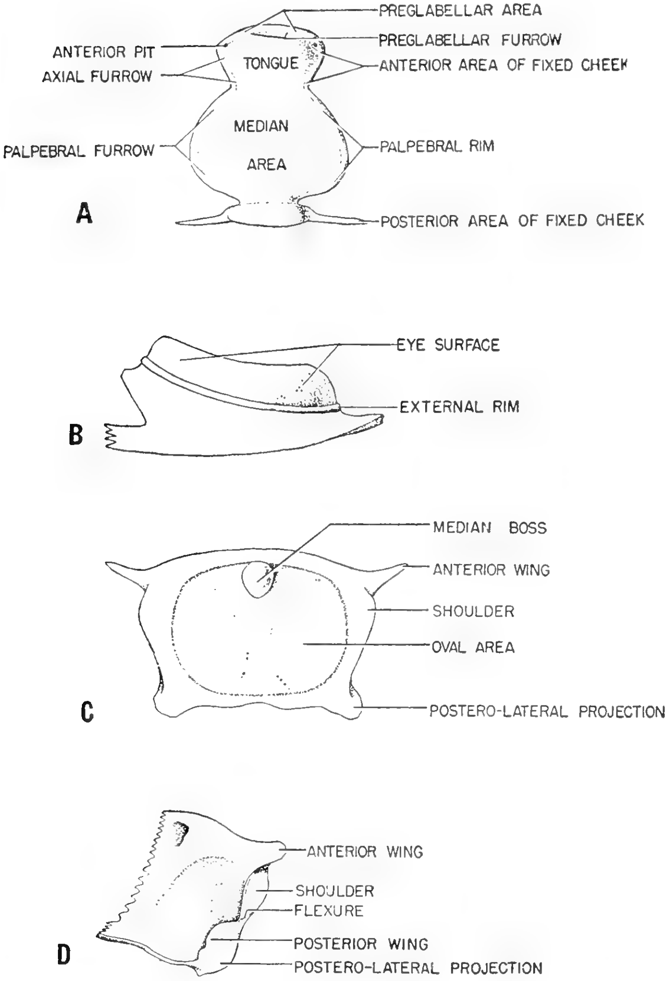


Figure 1. Diagrams illustrating some terms used in describing remopleuridids. A, cranidium (compare Pl. 1, figs. 1, 2). B, lateral view of free cheek (compare Pl. 1, fig. 16). C, exterior view of hypostome (compare Pl. 15, fig. 2). D, oblique interior view of part of hypostome (compare Pl. 15, fig. 3).

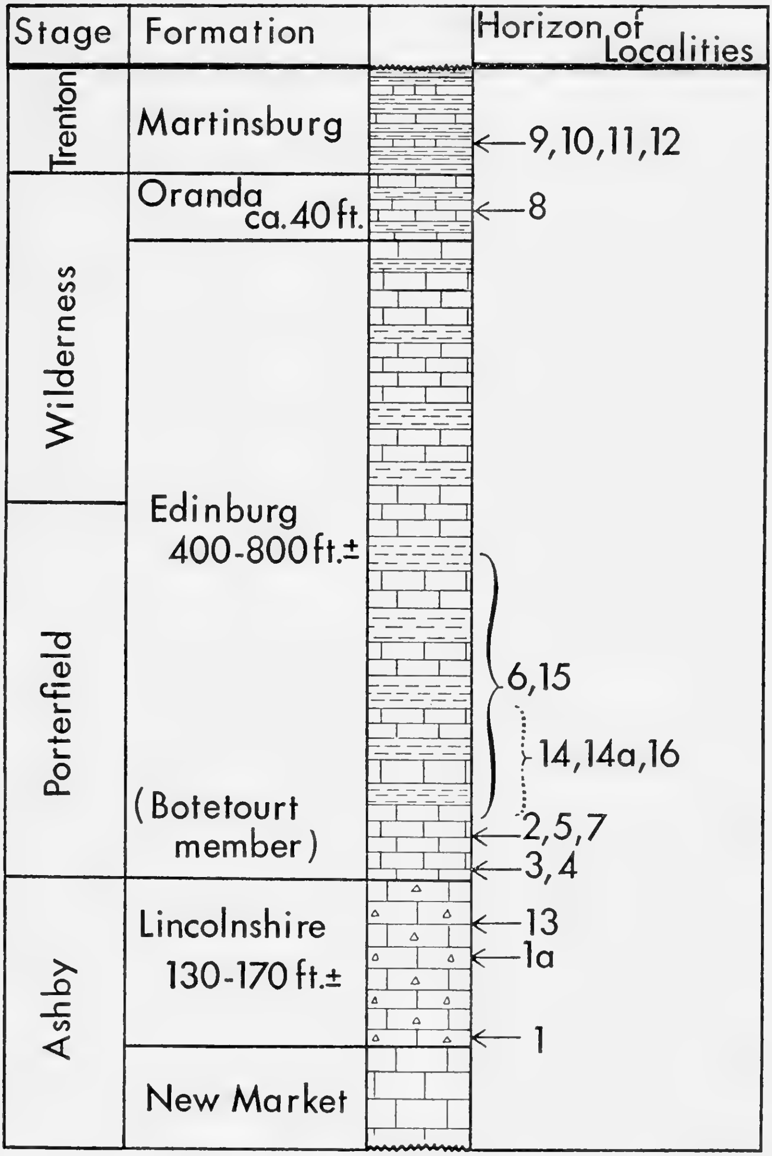
(1925, p. 4) the lower eye lid, and the furrow outside it was referred to as the lower lid furrow. I prefer to call this ridge the *external rim* of the eye lobe.

Hypostome. The external surface of the middle body generally displays a projection in the midline along the anterior border. This projection is referred to as the *median boss.* Most of the remainder of the middle body is occupied by the pair of ovate, slightly raised areas, the long axis of each oval directed diagonally. These areas are referred to here as the *oval areas* and are usually traversed by diagonally directed raised lines. The terms *shoulder* and *posterior wing* have been used as before, an additional term being *posterolateral projection* for the projecting part of the border at the posterolateral angle.

STRATIGRAPHICAL OCCURRENCE AND LOCALITIES

The specimens described here were obtained from limestones of the Lincolnshire, Edinburg, Oranda and Martinsburg formations of the Shenandoah Valley, northern Virginia (Text-fig. 2). The stratigraphy of these formations has been described by B. N. Cooper and G. A. Cooper (1946), B. N. Cooper (1953), and G. A. Cooper (1956), the last two publications describing respectively trilobites and brachiopods from these formations.

Figure 2. Generalized stratigraphical column of the Middle Ordovician rocks of the Shenandoah Valley, Rockingham and Shenandoah counties, Virginia (after Cooper and Cooper, 1946), showing approximate horizons of localities discussed. Stages from Cooper, 1956; the Chazy rocks are placed in the Marmor stage, which directly underlies the Ashby stage. Near the northern end of the outcrop under consideration the Edinburg formation is thinnest, displaying equal thicknesses of Lantz Mills (cobbly limestone) and Liberty Hall (black limestone and shale) facies. Southward the Edinburg thickens and is almost entirely Liberty Hall facies (Cooper and Cooper, 1946, fig. 4).


Stage
Formation
Horizon of Localities
Trenton
Wilderness
Porterfield
Ashby
Martinsburg
Oranda ca. 40 ft.
Edinburg 400-800 ft.±
(Botetourt member)
Lincolnshire 130-170 ft.±
New Market
9,10,11,12
8
6,15
14,14a,16
2,5,7
3,4
13
1a
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G. A. Cooper (1956, pp. 49-50) elevated the Botetourt limestone member of the Edinburg to a separate formation. He remarks that the formation is not easy to recognise in the present area of northern Virginia, and it is not clear from his discussion just which beds at Tumbling Run and Edinburg Dam should be included. Accordingly, Botetourt is here used as a member name in the sense of Cooper and Cooper, 1946. Descriptions of the silicified trilobites from these formations are referred to below, and Whittington and Evitt (1954) give an account of the mode of occurrence, preservation, and method of extraction of these silicified specimens. Localities are as follows:

Lincolnshire limestone

Locality 1 — Lower part of Lincolnshire limestone (Bed 3 of Cooper and Cooper, 1946, Geologic section 10, p. 76), in the interval between 20 and 24 feet above the contact with the underlying New Market limestone, Tumbling Run, 2 miles southwest of Strasburg, Shenandoah County, Virginia. Collected and specimens prepared by W. R. Evitt.

Locality 1a — Upper part of Lincolnshire limestone (Bed 5 of Cooper and Cooper, 1946, Geologic section 10, p. 76), about 90 feet above the contact with the underlying New Market limestone, Tumbling Run, 2 miles southwest of Strasburg, Shenandoah County, Virginia. Collected and prepared by W. R. Evitt.

Locality 13 — Upper part of Lincolnshire limestone (Bed 3 of Cooper and Cooper, 1946, Geologic section 11, p. 81), 30 to 50 feet below the contact with the overlying Edinburg formation, left bank of north fork of Shenandoah River, immediately below dam, and about 1.5 miles N.61° E. of Edinburg, Shenandoah County, Virginia. Collected and prepared by W. R. Evitt and Whittington.

Edinburg limestone

Locality 2 — Lower part of Edinburg limestone (bed 18 of Cooper and Cooper, 1946, Geologic section 19, pp. 94-95), yellowish-weathering argillaceous limestone forming edge of quarry and along strike of same bed, in field between quarry and railroad; just north of railroad tracks at switch a quarter of a mile east of Strasburg Junction, just west of Strasburg, Shenandoah

County, Virginia. Some of the finest specimens illustrated here came from blocks collected at this locality and were prepared by Dr. G. Arthur Cooper

Locality 3 — Lower part of Edinburg limestone, section in field on south side of road, 0.2 mile east of Strasburg Junction, just west of Strasburg, Shenandoah County, Virginia. The section dips about 38° SE. The lowest beds consisted of 6 feet of granular limestones with *Girvanella* sp., about 91 feet from the east edge of the quarry dump at the top of the field. These may be upper Lincolnshire limestone. About 20 feet stratigraphically higher, alternations of dark granular limestone and dark fine-grained limestone with sponge spicules were seen. These beds seem to be the basal Botetourt limestone member of the Edinburg formation (Cooper and Cooper, 1946, p. 80), and blocks from them were collected and prepared by Dr. G. Arthur Cooper, Dr. and Mrs. W. R. Evitt, and Whittington.

Locality 4 — Botetourt member, lower part of Edinburg limestone, in upper part of field northeast of Virginia State Highway 639, at a point 0.25 mile from its junction with U. S. Highway 11. This junction is 0.7 mile southwest of Strasburg, Shenandoah County, Virginia. The outcrop is approximately half a mile southwest of locality 3 along the strike of the beds. Collected and prepared by Dr. and Mrs. W. R. Evitt and by Whittington, and notable for yielding some of the finest tiny specimens.

Locality 5 — Lower part of Edinburg formation, bed 5 of type section (Cooper and Cooper, 1946, Geologic section 11, p. 81), left bank of north fork of Shenandoah River, immediately below dam, and about 1½ miles N.61°E. of Edinburg, Shenandoah County, Virginia. Collected and prepared by Dr. G. Arthur Cooper and Whittington.

Locality 6 — Edinburg limestone, lower part, Hupp Hill, at entrance to Battlefield Crystal Caverns, and in field on opposite (east) side of U. S. Highway 11, about 1½ miles north of Strasburg, Shenandoah County, Virginia. Discovered by Dr. G. Arthur Cooper, later collections by Whittington.

Locality 7 — Lower part of Edinburg limestone, 300 feet ± south 40° east of bridge, 1¼ miles east of Edinburg, Shenandoah County, Virginia. Originally collected by E. O. Ulrich, later (1931) by Charles Butts.

Locality 14 — platy black limestone, Edinburg formation, 500 feet east of Lacey Spring Post Office, Rockingham County, Virginia. Collected and prepared by Dr. G. Arthur Cooper and by Whittington.

Locality 14a — as locality 14, but ¾ mi. southwest of Lacey Spring Post Office, in field northwest of road. Collected by C. Butts, prepared by G. Arthur Cooper.

Locality 15 — lower part of Edinburg formation, section in field on south side of road, 0.2 miles east of Strasburg junction, just west of Strasburg, Shenandoah County, Virginia. The beds of locality 3 are about 50 feet thick, and locality 15 is in strata 50 to 180 feet above the top of these. Locality 15 is about the same horizon as locality 6. Collected by W. R. Evitt and Whittington.

Locality 16 — Liberty Hall facies (black limestone) of the Edinburg formation, in field on west side of Virginia secondary highway 617, near house 1/10 mile north-north-east of junction of Virginia secondary highways 617 and 753, 2½ miles north of Edom and about 8 miles north of Harrisonburg, Rockingham County, Virginia. Collected by G. Arthur Cooper and Whittington.

Oranda formation

Locality 8 — Lower 5 feet of formation, cobbly limestone, in bank and pasture on north side of Virginia secondary highway 777, just west of its junction with Virginia secondary highway 910, and circa 300 yards north of Greenmount church, five miles north of Harrisonburg, Rockingham County, Virginia. Discovered by G. Arthur Cooper, later collections by Cooper and A. R. Loeblich, Jr., W. R. Evitt, and Whittington.

Martinsburg shale

Locality 9 — Road cut, gutter, and loose blocks in pasture on west side of Virginia secondary highway 910, about half a mile north of Greenmount church, five miles north of Harrisonburg, Rockingham County, Virginia. Same as locality 1 of Evitt and Whittington, 1953, p. 55. Collected and prepared by Dr. and Mrs. W. R. Evitt, Dr. G. Arthur Cooper, and Whittington.

Locality 10 — Pasture on north side of Virginia secondary highway 772, about 1 mile east of Greenmount church, five miles north of Harrisonburg, Rockingham County, Virginia. Collected and prepared by Dr. and Mrs. W. R. Evitt.

Locality 11 — Loose blocks in pasture on north side of Virginia secondary highway 616, 1/4 mile east of intersection with Virginia secondary highway 699, and 2½ miles north-northeast of Spring Hill, 7 miles north of Staunton, Augusta County, Virginia. The Oranda formation immediately underlies the lower Martinsburg formation and outcrops a short distance to the west. This is the same locality from which I obtained all the material described by me in 1941. At that time (Whittington, 1941b, p. 492) two localities were given, distant respectively 2½ miles north-northeast, and 3 miles north-northeast, of Spring Hill and Long Glade. Spring Hill is a new name for the settlement formerly called Long Glade, and the confusion probably arose because the blocks of limestone were collected at different times (cf. Evitt, 1953, p. 34). The first blocks were collected by Dr. G. Arthur Cooper, later ones by Cooper and Whittington.

Locality 12 — In field on south side of Virginia secondary highway 753, 1 mile west of intersection with Virginia secondary highway 732, and 3½ miles north-northeast of Spring Hill, Augusta County, Virginia. This locality, visited by Dr. G. Arthur Cooper and Whittington, is one mile northeast of locality 11.

LISTS OF TRILOBITE FAUNAS

These lists have been compiled from previous publications, the present study, and from additional material yet to be described. The abbreviations used after the systematic names refer to citations in the bibliography as follows: W, 41 = Whittington, 1941b; W, 49 = Whittington, 1949; E, 51 = Evitt, 1951; C, 53 = Cooper, 1953; E, 53 = Evitt, 1953; E and W, 53 = Evitt and Whittington, 1953; W and E, 54 = Whittington and Evitt, 1954; W, 56 = Whittington, 1956. These references are in most cases to the original description of species not considered here, but in a few instances are to descriptions of silicified material of previously published species.

Lincolnshire limestone

	Lower	Upper	
Locality	1	1a	13
Dimeropygidae			
Dimeropyge spinifera W and E, 54	x		
Mesotaphraspis inornata W and E, 54	x		
Chomatopyge marginifera W and E, 54	x		
Remopleurididae			
Remopleurides asperulus n. sp.		x	x
Harpidae			
Dolichoharpes reticulata W, 49; E, 51	x		
Cheiruridae			
Heliomeroides teres E, 51	x		
Ceraurinella chondra W and E, 54	x		
Acanthoparypha chiropyga W and E, 54	x		
Holia secristi W and E, 54	x		
Sphaerexochus hapsidotus W and E, 54	x		
Lichidae			
Amphilichas pandus E, 51	x		
Odontopleuridae			
Ceratocephala triacantheis W and E, 54	x		

In addition there are species of proetids, otarionids, asaphids, encrinurids and dalmanitids. The upper Lincolnshire fauna has not been intensively prepared or studied.

Lower Edinburg limestone

Lantz Mills facies, and 20 to 30 feet above base, including Botetourt member at locality 4.

Locality	2	3	4	5	7
Agnostidae					
Trinodus elspethi C, 53	x				x
Dimeropygidae					
Dimeropyge virginiensis W and E, 54	x				x
Mesotaphraspis parva W and E, 54	x	x			
Chomatopyge falcata W and E, 54	x		x		
Proetidae					
"Proetus" strasburgensis C, 53	x				
Styginidae					
Raymondaspis gregarius (C, 53)	x				

Locality	2	3	4	5	7
Remopleurididae					
Remopleurides caelatus n. sp.	x	x	x		x
Remopleurides caphyroides n. sp.	x	x	x	x	
Remopleurides eximius n. sp.	?	x	x		
Remopleurides simulus n. sp.		x			
Remopleuridid gen. et sp. ind.		x	x		
Harpidae					
Dolichoharpes reticulata W, 49	x	x	x		
Trinucleidae					
Tretaspis sagenosus n. sp.	x	x	x		x
Raphiophoridae					
Ampyx virginiensis	x	x	x	x	
Lonchodomas carinatus	x	x		x	
Ampyxina powelli				x	
Raymondella elegans		x			x
Cheiruridae	x				
Ceraurinella typa W and E, 54	x		x	x	
Acanthoparypha perforata W and E, 54					
Holia cimelia W and E, 54	x	x			
Sphaerexochus pulcher W and E, 54	x				x
Dalmanitidae					
Calliops strasburgensis C, 53	x				
Calliops callirachis C, 53	x				
Odontopleuridae					
Diacanthaspis lepidus W, 56	x	x	x		
Diacanthaspis secretus W, 56	x	x	x		
Diacanthaspis ulrichi W, 56			x		x
Ceratocephala laciniata W and E, 54	x	x	x		
Ceratocephala (Ceratocephalina) tridens W, 56		x	x		
Apianurus barbatus W, 56	x	x	x		
Apianurus glaber W, 56	x	x	x		
Apianurus sp. ind. W, 56	x				
Calipernurus insolitus W, 56	x	x			

In addition there are species of proetids, asaphids, illaenids, other cheirurids, encrinurids, and lichids. Only one small block from locality 5 was prepared.

Lower Edinburg limestone (Liberty Hall facies)

Locality	14	14a	16
Agnostidae			
Trinodus elspethi C, 53			x

Locality	14	14a	16
Dimeropygidae			
Mesotaphraspis parva W and E, 54			x
Styginidae			
Raymondaspis gregarius (C, 53)			x
Remopleurididae			
Remopleurides caelatus n. sp.			x
Robergia major	x		x
Robergiella sagittalis n. gen., n. sp.	x	x	x
Trinucleidae			
Tretaspis sagenosus n. sp.		x	x
Raphiophoridae			
Ampyx virginiensis			x
Ampyxina powelli	x		
Ampyxina lanceola n. sp.			x
Raymondella elegans			x
Endymioniidae			
Salteria americana	x		
Cheiruridae			
Ceraurinella typa W and E, 54			x
Acanthoparypha perforata W and E, 54			x
Dalmanitidae			
Calliops sp.			x
Odontopleuridae			
Diacanthaspis ulrichi W, 56			x

In addition there are proetids, an asaphid, and an encrinurid. A large number of blocks from locality 14 have been dissolved in acid, but few blocks from 14a.

Lower Edinburg limestone

100-250 feet above base, Lantz Mills facies

Locality	6	15
Agnostidae		
Trinodus elspethi C, 53	x	
Styginidae		
Raymondaspis gregarius (C, 53)	x	
Remopleurididae		
Remopleurides caelatus n. sp.	x	x
Remopleurides caphyroides n. sp.	x	x
Raphiophoridae		
Ampyx virginiensis	x	
Lonchodomas carinatus	x	

Locality	6	15
Cheiruridae		
Ceraurinella typa W and E, 54	x	
Acanthoparypha perforata W and E, 54	x	
Dalmanitidae		
Calliops loxorachis C, 53	x	
Odontopleuridae		
Diacanthaspis secretus W, 56	x	
Ceratocephala laciniata W and E, 54	x	
Apianurus barbatus, W, 56	x	

In addition there is a proetid. Little material from locality 15 has been prepared.

Oranda formation, locality 8

- Dimeropygidae
  - *Dimeropyge* sp.
- Otarionidae
  - *Otarion* sp.
- Trinucleidae
  - *Cryptolithus* sp.
- Cheiruridae
  - *Ceraurus* sp.
  - *Acanthoparypha* sp.
- Calymenidae
  - *Flexicalymene* sp.
- Odontopleuridae
  - *Diacanthaspis orandensis* W, 56
  - *Diacanthaspis scitulus* W, 56
  - *Diacanthaspis* aff. *ulrichi* W, 56
  - *Ceratocephala rarispina* W, 56
  - *Apianurus barbatus* W, 56

In addition were found an asaphid, an illaenid, a dalmanitid, an encrinurid and a lichid.

Lower Martinsburg shale

Locality	9	10	11	12
Otarionidae				
"*Otarion*" sp. W, 41	x		x	
Asaphidae				
Isotelus sp. W, 41	x		x	x

Locality	9	10	11	12
Remopleurididae				
Remopleurides plaesiourus n. sp.	x	x		x
Trinucleidae				
Cryptolithus tesselatus	x	x	x	x
Cheiruridae				
Ceraurus whittingtoni E, 53	x		x	
Calymenidae				
Flexicalymene senaria W, 41; E and W, 53	x		x	x
Dalmanitidae				
Dalmanitid	x		x	x
Odontopleuridae				
Primaspis ascitus W, 56		x		
Diacanthaspis cooperi W, 56	x	x	x	x

FAUNAL AFFINITIES

Appalachian. The distribution of some of these trilobites in rocks of Middle Ordovician age in the Appalachian Valley between Pennsylvania and Alabama has been discussed by B. N. Cooper (1953). G. A. Cooper (1956) erected five new stages to accommodate the rocks between the Canadian and typical Trenton limestone, and, on the basis of brachiopod studies, gave his reasons for correlations and age assignments of particular formations. He regards the Lincolnshire limestone as younger than the Chazy because it contains only two Chazyan brachiopod genera and five post-Chazyan genera. Of the trilobite genera from the Lincolnshire listed above, *Remopleurides*, *Sphaerexochus*, *Amphilichas*, a proetid, sundry asaphids and encrinurids, and the dalmanitid *Calliops* are known in the Chazy. The dimeropygids and such cheirurids as *Ceraurinella*, *Acanthoparypha* and *Holia* are not known in the Chazyan but range through and above the Lincolnshire, and the Lincolnshire lacks such Chazy forms as *Uromystrum*, *Vogdesia*, *Glaphurus*, *Pliomerops*, *Heliomera* and other cheirurids. The evidence of the trilobites thus seems to support G. A. Cooper's view that the Lincolnshire limestone is post-Chazyan in age (i.e. Ashby stage, Text-fig. 2) and displays affinities with faunas of the succeeding Porterfield stage.

Many of the Edinburg formation trilobites are like those of the lower Lincolnshire limestone, being different species of the same genera. The Edinburg, Lantz Mills facies, of cobbly, buff-weathering limestone (Cooper and Cooper, 1946, p. 78), has a richer and more varied fauna, however, including *Trinodus, Raymondaspis,* four species of *Remopleurides, Tretaspis,* the raphiophorids and odontopleurids. The typical Liberty Hall facies of black limestone and shale in the lower Edinburg of locality 14 (cf. Cooper and Cooper, 1946, p. 78, fig. 4) has a restricted trilobite fauna unlike that of the Lincolnshire. Locality 16 has an intermediate fauna including typical Liberty Hall elements and many Lantz Mills forms. G. A. Cooper (1956, pp. 43, 50, 61) regards the fauna of the lower Edinburg formation, Botetourt member, as clearly related to that of the Effna formation. The similarity between the trilobites is not great (B. N. Cooper, 1953, Table 1) and the differences may reflect facies differences — the Effna formation is a calcarenite and reef facies, the Botetourt member a dark, granular limestone. The Youngman formation of Vermont is said by G. A. Cooper (1956, p. 32 and Chart 1) to be of the same age as the Botetourt and earliest Edinburg limestone. From the Youngman formation, Kay (1958, p. 83) has recorded *Isotelus* sp., *Illaenus* sp., *Remopleurides* sp., *Lonchodomas* (a species remarkably like that described here), and *Calliops* sp., all typical elements of the lower Edinburg trilobite fauna.

It is G. A. Cooper's belief (1956, pp. 9, 81-82) that the Oranda formation is pre-Sherman Fall (or pre-Shoreham), i.e. latest Wilderness stage and immediately pre-Trenton (Text-fig. 2), and that the brachiopod fauna is similar to that of the lower Edinburg but modified by Trenton elements. The trilobite fauna is of the same type — occurring with the abundant species of Edinburg type are extremely rare examples of typical Sherman Fall genera — *Ceraurus* sp., *Flexicalymene* sp. and *Cryptolithus* sp.. The overlying lower Martinsburg shale, believed by G. A. Cooper (1956, pp. 9, 77, and Chart 1) to be of Shoreham age, yields abundant *Cryptolithus, Ceraurus* and *Flexicalymene,* as well as *Primaspis,* all typical Shoreham genera.

Thus the trilobite faunas of lower Lincolnshire to lower Martinsburg age suggest similar correlations to those advanced by G. A. Cooper on the basis of brachiopods. The Porterfield stage trilobite fauna, however, is not an ''exotic fauna that floods into the Appalachians and blots out and absorbs the Lincolnshire fauna'' (G. A. Cooper, 1956, p. 8). A large part of it is directly descended from that of the Lincolnshire, but there are some additional new elements. In the Shenandoah valley of Virginia the trilobites hardly suggest the division into Porterfield and Wilderness stages, but this is because silicified trilobites are virtually unknown from the middle and upper Edinburg formation (*Nidulites* and *Camarocladia* zones). Brachiopods are best known from the lower and middle Edinburg formation, and apparently also do not show clearly the Porterfield-Wilderness boundary (cf. G. A. Cooper, 1956, pp. 8-9, 59-60). The change at the end of the Wilderness, into the Trenton, is well marked in the trilobite faunas.

European. The Balclatchie beds of the Girvan district, Scotland, are of about the same age as the lower Edinburg formation (cf. G. A. Cooper, 1956, p. 8), and the Scottish species of *Trinodus, Raymondaspis, Remopleurides, Lonchodomas,* and *Raymondella* are very like those from silicified material in Virginia. Among the trilobites from the Craighead mudstones in the same area in Scotland (Tripp, 1954) are species of *Diacanthaspis, Remopleurides,* and *Calliops* that resemble species from Virginia. The Chasmops series of Norway yields *Raymondaspis, Remopleurides, Ampyx, Lonchodomas,* and *Apianurus* (Størmer, 1940; Skjeseth, 1955, p. 26; Whittington, 1956, pp. 270-271), and the same series in Sweden (Thorslund, 1940) contains *Trinodus, Dimeropyge, Raymondaspis, Remopleurides, Sphaerexochus,* and *Apianurus* (Whittington, 1956, p. 271). From the Kukruse (C_2) stage of Estonia (Öpik, 1937) come *Dimeropyge, Remopleurides,* and *Apianurus* (Whittington, 1956, p. 271). Thus in the Baltoscandian area rocks of a similar age to the Edinburg limestone of Virginia contain a number of species of similar trilobite genera. However, in these European areas there are a number of genera — for example, *Hibbertia, Chasmops, Flexicalymene* — that are either not known in the lower Edinburg of Virginia or appear higher in the succession. Similarly, in Virginia there are species of genera such as *Tretaspis* that appear earlier than in Europe, and other genera that are not yet known from Europe.

SYSTEMATIC DESCRIPTIONS AND DISCUSSIONS

Family REMOPLEURIDIDAE Hawle and Corda, 1847

Subfamily REMOPLEURIDINAE Hawle and Corda, 1847

Genus REMOPLEURIDES Portlock, 1843

Type Species. Remopleurides colbii Portlock, 1843 (for redescription see Whittington 1950b, pp. 540-543, pl. 70, figs. 1, 2, 4, 5).

Diagnosis. Axis of exoskeleton relatively wide. Eye lobe long (exs.), eye surface curved through approximately 180°, anterior part of eye lobe close to, or overhanging, anterolateral cephalic border, posterior part of eye lobe abuts against extremity of occipital ring. Glabella narrow at occipital furrow, in front of this occupying entire area between eye lobes so that palpebral and axial furrows are synonymous, tongue of varying width and length, separated from eye lobe by axial furrow and narrow anterior area of fixed cheek, longitudinal and transverse convexity of glabella variable; three pairs of lateral glabellar furrows visible because exoskeleton is thinner along them, equally spaced from each other and the extremities of the eye lobe, first and second furrows long and gently curved, third furrow short. Shallow anterior pit at anterior extremity of axial furrow. Anterior branches of facial suture curve forward and inward from outer, anterior angle of eye lobe to run along the margin of the cephalon immediately in front of the preglabellar furrow and meet in the midline; posterior branches curve outward and backward, isolating a slim, wedge-shaped posterior area of the fixed cheek that varies in width (tr.). Free cheek subtriangular in outline, posterior margin may run transversely or run outward and forward, a projection adjacent to the posterior branch of the suture defines the outer part of the articulating socket. Position of base of genal spine variable, may be opposite occipital ring or in advance of this position, librigenal spine may be extremely short or long and curved; some species with acute genal angle to free cheek and librigenal spine situated on the lateral border in front of this angle. Hypostome subsquare to transversely subrectangular in outline, convex lateral and posterior borders, anterior and posterior wings present, median boss of variable prominence, oval areas of thinner exoskeleton on middle body: shoulder and posterolateral projection separated by a lateral excavation of variable depth, posterolateral projection may be extended into a blunt spine. Doublure of cephalon broadest anteriorly, crossed by median suture: deep pit in anterolateral portion of doublure, the tip of which reaches the inner surface of the anterior pit.

Thorax (where completely known) of eleven segments, the broad axis tapering back to two-thirds or half its width: large articulating processes and sockets in the axial furrow, pleurae of variable width (tr.), crossed by diagonal pleural furrow: blade-shaped terminal spine of variable length, longer pleurae may be developed on the seventh segment and a median axial spine on the eighth; doublure extends inward to axial furrow. Pygidium of two segments, axis short and rapidly tapering, first axial ring may expand distally and the second axial ring subdivided by a median longitudinal furrow; pleural regions of varying length (sag. and exs.), two pairs of bladelike pleural spines varyingly developed; doublure extends in to tip of axis, median projection from inner edge.

External surface with raised anastomosing lines, may be in a Bertillon pattern on the glabella, elsewhere on the axis running transversely, on the pleural regions running longitudinally or in curves convex forwards: granulation may also be present on the glabella, and rows of tubercles along the posterior edge of the occipital and axial rings. Raised lines, running subparallel to the margins, on the doublure.

Morphology of the holaspid

Morphological features have been summarized in the diagnosis of *Remopleurides.* The developmental series have revealed the limits of the glabella in the holaspis by showing that palpebral furrow and axial furrow, at first separate, become confluent. The three pairs of glabellar furrows are not furrows in the sense of being considerable depressions in the external surface, but are visible because they are lines along which the exoskeleton is thinner (Pl. 5, fig. 2). On the external surface raised lines and granulation are faint or absent along these furrows, and they may be faintly depressed (Pl. 1, fig. 1; Pl. 5, fig. 1; Pl. 8, fig. 5);

on the inner surface they are excavated (Pl. 1, fig. 6; Pl. 12, fig. 14).

Tripp (1954, p. 665) mentioned the presence of a shallow anterior pit in *Remopleurides biaculeatus*, and the presence of a deep pit in the doublure which projected upwards so that the tip rested against the anterior pit. The silicified specimens described here show these features in detail (Pl. 2, figs. 23-25; Pl. 8, figs. 8-10; Pl. 15, figs. 17, 18). Externally the anterior pit is shallow but makes a distinct rounded boss on the inner surface, and there is a depression in this boss. This depression appears to have received the tip of the cone (as seen on the internal surface) extending in from the doublure. The tip of the cone may be rounded and closed (Pl. 8, fig. 9; Pl. 15, fig. 18) or exhibit a minute opening (Pl. 2, fig. 24). The opening may be the result of incomplete preservation or breakage of the thin exoskeleton at the tip. I have observed the pit in the doublure of other species of *Remopleurides* and it is also present in the closely related genus *Hypodicranotus* Whittington, 1952b.

At least the median half of the anterior edge of the hypostome appears to have fitted along a sutural boundary with the inner edge of the doublure of the free cheeks (Pl. 1, figs. 10-12; Pl. 7, figs. 4, 5, 7, 9; Pl. 8, fig. 7). Just inside this edge of the doublure runs a sharp double flexure, strongest near the median suture, dying out a short distance away (Pl. 1, fig. 10; Pl. 2, fig. 23; Pl. 8, fig. 9; Pl. 15, fig. 17; Pl. 17, figs. 3, 10). Distally the edges of hypostome and doublure appear to have separated, that of the former curving above (i.e. dorsally to) the inner edge of the doublure, so that the anterior wing probably projected above and inside this edge. Laterally the inner edge of the doublure of the free cheek is curled over, but this curled portion diminishes and disappears about where the anterior wing lay close to the doublure of the free cheek. There is no wing process, and the anterior wing does not seem to have lain against, or very close to, the anterior boss. The thick, flat edges of the hypostome and doublure of the free cheeks along the hypostomal suture (Pl. 15, figs. 5, 18) do not suggest that movement took place along this suture. Presumably the hypostome was more or less rigidly attached along this suture and held in position by muscles.

If the ventral aspect of the cephalon of the cheirurid *Ceraurus* (Text-fig. 3A; cf. the similar genus *Ceraurinella* in Whittington

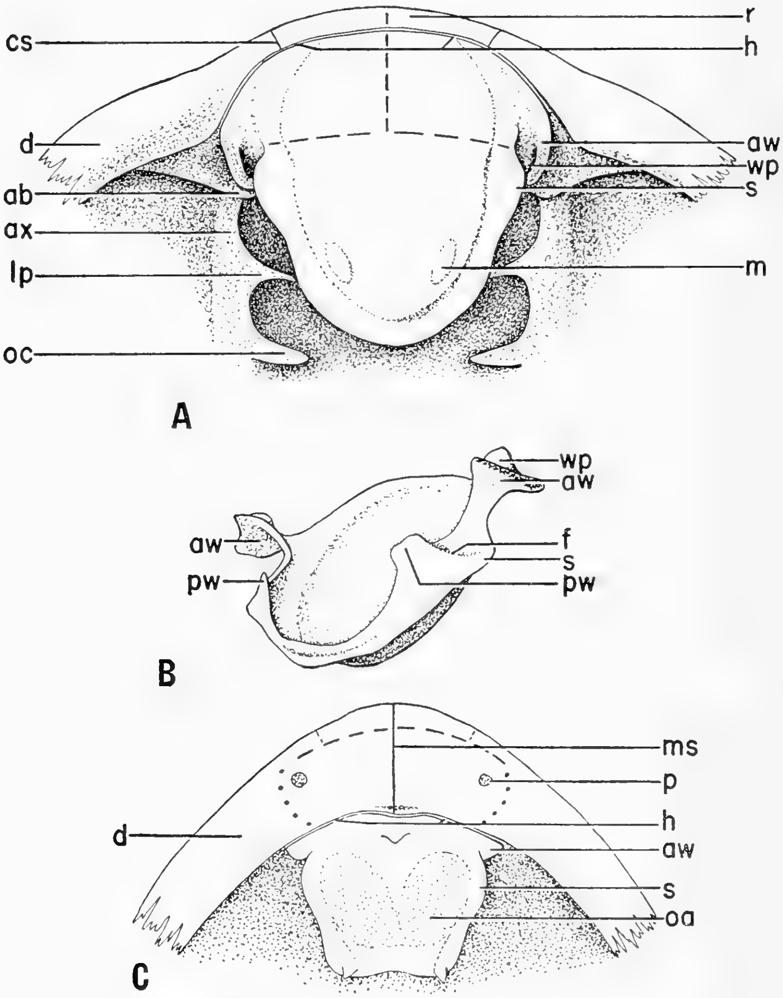

Figure 3. A, ventral view of part of cephalon of *Ceraurus* sp., showing hypostome in position. B, oblique interior view of hypostome of *Ceraurus* sp. C, ventral view of part of cephalon of *Remopleurides caelatus* n.sp., showing hypostome in position. Abbreviations: *ab*, anterior boss; *aw*, anterior wing; *ax*, axial furrow; *cs*, connective suture; *d*, doublure; *f*, flexure crossing doublure; *h*, hypostomal suture; *lp*, ridge formed by first (basal) glabellar furrow; *m*, macula; *ms*, median suture; *oa*, oval area of hypostome; *oc*, appendifer at extremity of occipital furrow; *p*, pit in doublure; *pw*, posterior wing; *r*, rostrum; *s*, shoulder; *wp*, wing process. For explanation of dashed and dotted lines, see text.

and Evitt, 1954, pp. 19-20) is compared with that of *Remopleurides* (Text-fig. 3C) the similarity in structure of the wing process of *Ceraurus* and the pit in the doublure of *Remopleurides* is evident. Both extend dorsally as a cone, the tip lying against the anterior boss. Yet in *Ceraurus* the wing process (Text-fig. 3A, B) is part of the hypostome, while in *Remopleurides* the pit is situated in the cephalic doublure in front of the hypostome. If they are assumed to be homologous structures then the median and hypostomal sutures of *Remopleurides* lie in positions which are shown by dashed lines in *Ceraurus* (Text-fig. 3A). In the drawing of *Remopleurides* (Text-fig. 3C) the position in which the rostral, connective and hypostomal sutures of *Ceraurus* lie is shown likewise by dashed lines, and dots indicate roughly the remainder of the boundary of the part that is included in the hypostome of *Ceraurus*. If one accepts this hypothesis then it follows that:

1) the hypostomal suture in *Remopleurides* and *Ceraurus* is not a homologous but an analogous structure;

2) the portion of the exoskeleton included in the hypostome is not the same in *Remopleurides* as in *Ceraurus*. This may be also true as between *Remopleurides* and other types of trilobites;

3) the anterior wing in *Remopleurides* is not homologous with that of *Ceraurus*;

4) the doublure immediately behind the shoulder in *Ceraurus* is crossed diagonally by a sharp flexure (*f* in Text-fig. 3B), and the inner edge projects as the posterior wing (as in *Ceraurinella*, Whittington and Evitt, 1954, text-fig. 2, pl. 11, fig. 12). The same is true in *Remopleurides* (Pl. 1, figs. 13, 15; Pl. 15, fig. 3; Text-fig. 1d), so that the shoulder and posterior wing appear to be homologous in the two genera;

5) the macula in many trilobites is a relatively small oval area, situated anterior to the inner end of the middle furrow of the middle body, and the exoskeleton over the macula appears to be thinner than surrounding areas and the external surface smooth (Whittington and Evitt, 1954, pp. 16-17). It seems possible that the oval area of the hypostome of *Remopleurides* may be homologous with the macula of other trilobites, for the position is similar and the exoskeleton over the oval area is thinner than adjacent parts. The external surface of the oval area may be traversed by fine, raised lines (Pl. 1, fig. 10; Pl. 4, figs. 3, 4)

or may appear smooth (Pl. 7, fig. 5; Pl. 15, fig. 2; Pl. 17, fig. 18). If it is homologous with the macula of other trilobites then it is exceptionally large in *Remopleurides* (compare illustrations in Lindström, 1901 and Whittington and Evitt, 1954).

6) It has been argued (Whittington and Evitt, 1954, p. 20) that in trilobites the antennule was attached to the anterior boss and curved downwards and forwards beside the hypostome, passing through the lateral notch. This may have been the case in *Remopleurides,* but if so the antennule was directed at first backward, and then curved downward, outward and presumably forward, passing between the shoulder and anterior wing.

In posterior view the hypostome shows the doublure projecting upward, with a small lateral notch beside a larger, deeper, median scallop, and the doublure at this scallop is not upwardly directed but curled over so that the inner edge is directed forward (Pl. 1, figs. 14, 15; Pl. 4, fig. 30; Pl. 15, fig. 5; Pl. 17, figs. 21-23). This median scallop is suggestive of the position of the mouth.

A median axial spine is present on what is most probably the eighth thoracic segment of all the species described here, and is characteristic of other species. In *Remopleurides eximius* and *R. asperulus* the pleurae of the seventh thoracic segment are longer than those of the other pleurae. A specimen from Eire referred to *R. colbii* (Whittington, 1950b, pl. 69, figs. 5, 6) also has the thoracic pleurae of the eighth segment elongated. It may be that this character is a manifestation of sexual dimorphism, and not a specific character, but specimens without such spines do not occur at localities 1a and 13 with *R. asperulus.* The possibility that the specimens here called *R. simulus* are sexual dimorphs of *R. eximius* is discussed under the heading *R. simulus.* Compared to trilobites belonging to other families in the silicified material from Virginia, there are a remarkable number of specimens of *Remopleurides* in which up to as many as nine thoracic segments are linked together with the pygidium (Pl. 12, figs. 15-18; Pl. 14; Pl. 15, figs. 6-8, 11, 12). Perhaps the long articulating half rings and the prominent axial articulating bosses and sockets hold the segments of the (cast?) exoskeleton together more firmly than is the case in many other trilobites. The photographs of such specimens and of single segments (Pl. 2, fig. 5; Pl. 12, fig. 16; Pl. 17, fig. 16) show the facet — the smooth anterior and anterolateral part of the pleura that fits during enrollment beneath the preceding segment. A similar facet is present on the pleural regions of the pygidium (Pl. 15, fig. 14). There is in the doublure of each pleura a depression along the posterior margin, bounded by a sharp change in slope (Pl. 2, fig. 8; Pl. 9, figs. 4, 8; Pl. 12, fig. 17). This depression receives the facetted portion of the following pleura during enrollment. In species such as *R. eximius* and *R. simulus,* in which the genal angle is about opposite the occipital ring, a similar depression is present in the doublure of the free cheek (Pl. 17, fig. 10). During enrollment the facet can move beneath the preceding segment as far as the sharp flexure that limits the depression: that is, the sharp flexure that forms the anterior edge of the depression in the doublure acts as a limit to the possible amount of enrollment. This is well illustrated by the nine segments and pygidium of *R. simulus* (Pl. 17, figs. 12-14). It would appear probable from an examination of this specimen in ventral aspect that the limit of enrollment had been reached for this portion of the thorax. If this is so, even allowing for a further two segments in the thorax, it seems that *R. simulus* could not have enrolled so that the pygidium was closely pressed beneath the cephalon — as is the case in a great many trilobites. An approximately similar amount of enrollment, that is, the thorax curved through about 180°, is shown by the type specimen of *R. rugicostatus* Raymond, 1925 (Pl. 18, figs. 26, 27). In *Hypodicranotus* (Whittington, 1952b), a genus closely related to *Remopleurides,* far less enrollment was possible because of the exceptional size of the hypostome.

Discussion of Development

Protaspis. The spherical form, convexity and definition of axis, lateral cranidial outline, and three pairs of prominent spines of the protaspides attributed to four species described herein (Pl. 3, figs. 1-5; Pl. 5, figs. 18-20; Pl. 10, figs. 15, 18-20; Pl. 11, figs. 1-4; Pl. 13, figs. 1-4, 10) recall at once the protaspis of *Menoparia* (Ross, 1951, pp. 579-583, pl. 81, figs. 1-9; 1953, pp. 634-635). It is because of this resemblance, and their likeness to larger members of the developmental series, that they are placed in *Remopleurides.* In the case of *R. asperulus* and *R.*

plaesiourus no other species of *Remopleurides* occurs at the same horizon, and there can be little doubt regarding the identification. *Menoparia* is from rocks of lower Ordovician age and I consider (Whittington 1959, p. O329) that it belongs to a separate subfamily of remopleuridids from that which includes *Remopleurides.* This type of protaspis may well be common to the family. It has been demonstrated that in the species here described the median pair of spines are fixigenal, lying immediately in front of the faint furrow that divides the cephalic from the protopygidial portion (Text-fig. 4). It may be that the corresponding spines in the protaspis of *Menoparia* also are fixigenal, and do not belong to the protopygidium, as Ross thought. In the protopygidium of the protaspis of *Menoparia,* Ross described the axis as possessing two segments. In the protopygidium of *R. caphyroides* more divisions can be seen clearly, five axial rings and a terminal portion. The pleural regions of the protopygidium of *R. eximius ?* (Pl. 16, figs. 3, 7, 9) are subdivided faintly by bands of granules. Along the posterior margin of the protopygidium in all species a row of five pairs of tiny spines is characteristic, and in *R. caelatus, R. plaesiourus* and *R. caphyroides* the outer pair is larger and in advance of the others. In *Menoparia* and *Remopleurides* (Text-fig. 4) the cephalic sutures follow a scalloped course, outlining the palpebral lobe and the position of the two branches of the suture. In the protaspides of neither genus are the free cheeks and hypostome known.

Degree 0. Meraspides of this degree (Pl. 3, figs. 7-15; Pl. 5, figs. 16, 17, 21-23; Pl. 10, figs. 8-14, 16, 17; Pl. 13, figs. 5-7, 11-15; Pl. 16, figs. 8, 10-17; Text-figs. 5, 6) retain the long anterior cephalic spines (with the possible exception of *R. asperulus*) and a tiny remnant of the fixigenal spine in *R. caelatus, R. plaesiourus* and *R. caphyroides.* The transitory pygidium of the latter three species retains only four pairs of marginal spines, but there are five pairs in *R. asperulus* and *R. eximius?.* The axis displays five axial rings (six in *R. asperulus* and *R. eximius?*) and a strongly convex terminal portion. These specimens are remarkably like the corresponding developmental stages of *Menoparia* described by Ross (1953, pp. 634-635, pl. 62, figs. 6, 7, 9-11, 13, and 16) and I think there is little doubt but that the originals of Ross' figures 7, 9, 10, 11, 13, and 16 are the smallest transitory pygidia of *M. genalunata*. They are extremely similar in form to those of *Remopleurides caelatus, R. plaesiourus,* and *R. caphyroides,* displaying five axial rings and a strongly convex terminal portion of the axis. The posterior margin bears five pairs of tiny spines rather than four. Ross does not mention the presence of the pair of tiny tubercles near the anterior margin of the glabella in either the protaspis or the smallest cranidia. However, a pair of such tubercles appears to be present at the anterior end of the meraspid glabella in the original of Ross' (1953) plate 62, figure 6. The presence of these tubercles is another striking similarity to *Remopleurides*.

Larger cranidia. Specimens in this size series cannot be assigned to particular degrees. The smallest are little larger than those of degree 0, and lack the anterior cephalic spine (compare Pl. 3, fig. 9 with Pl. 3, fig. 16; Pl. 5, fig. 16 with Pl. 6, figs. 1-4; Pl. 10, figs. 8, 9, 11 with Pl. 10, figs. 5-7; Pl. 13, fig. 5 with Pl. 13, fig. 17). This spine is reduced as abruptly as between the corresponding stages in *Menoparia* (Ross, 1951, pl. 81, figs. 12, 14). The reduction of fixigenal and protopygidial spines between the protaspis and Degree 0 of *Remopleurides caelatus, R. plaesiourus,* and *R. caphyroides* is equally as abrupt. Odontopleurids also show loss of spines between developmental stages, in this case the loss of the fixigenal spine between degree 0 and immediately succeeding degrees (Whittington, 1956, text-figs. 11, 22).

In the smallest post-degree 0 cranidia of *Remopleurides* the palpebral rim is well defined and there is a crescentic portion of the fixed cheek enclosed between the axial furrow and the palpebral furrow (e.g. Pl. 3, fig. 16; Pl. 6, figs. 2, 3; Pl. 13, fig. 17). Such an area is present at a similar developmental stage of *Menoparia* (Ross, 1951, pl. 81, fig. 14), and is reduced in large cranidia by expansion of the glabella (Ross, 1953, pl. 62, fig. 4), but never disappears. In *Remopleurides,* on the other hand, the glabella rapidly expands between the eye lobes and the crescentic area narrows and then disappears, so that the axial and palpebral furrows approach and merge into a single furrow (Pl. 4, figs. 1, 7, 9, 14; Pl. 6, figs. 2, 3, 5, 8, 11, 12; Pl. 13, figs. 17, 20, 24, 28). Other changes that take place in this size series are the general increase in convexity of glabella, both longitudinally and transversely, and the reduction in width (tr.) of the anterior area of the fixed cheek.

Transitory pygidia. In *Remopleurides caelatus* the next transitory pygidia known after those of degree 0 are believed to belong to degrees 5, 6, and 7, and have a long median axial spine (Pl. 4, figs. 5, 6, 13, 16-18, 22). In the development of *Menoparia,* Ross (1953, pl. 62, fig. 20) found a similar type of pygidium to be next in the series. In *R. caelatus* no intermediates are known between the degree 0 and degree 5 transitory pygidia. It is possible that the absence of such specimens implies that they may not have existed; that is, that there was a simultaneous release of four segments into the thorax so that the degree 0 transitory pygidium was succeeded by that of degree 5. In the material at hand the median axial spine appears suddenly and is of extraordinary length. It must develop, perhaps abruptly between moults, from the region represented by the strongly convex terminal axial portion of the degree 0 transitory pygidium (Pl. 3, figs. 10-13, 15). Transitory pygidia of degrees 8 to 10 (Pl. 4, figs. 23-25, belonging to the developmental stages after the release of the segment bearing the median axial spine into the thorax), progressively approach the appearance of the true pygidium and do not have the strongly convex terminal axial portion of the degree 0 transitory pygidium.

Discussion. The development of *Remopleurides* is best known from *R. caelatus*, the less complete developmental series of other species showing, however, that they are similar. The remarkable parallels that have been drawn between the development of the Lower Ordovician species of *Menoparia* and Middle Ordovician species of *Remopleurides,* serve to illustrate the principle that related animals display similar early developmental stages. A comparison between the illustrations given here, and those of Ross, shows that the protaspides and to a lesser extent meraspid degree 0 have a family resemblance to each other. Subfamily and generic characters are visible at immediately succeeding degrees — for example, the shape of the glabella, width (tr.) of the anterior area of the fixed cheek, length (sag. and exs.) of the preglabellar area, form of the pleural regions in *Menoparia.* When comparison is made between the developmental series of the new species of *Remopleurides,* it is evident that specific characters can be picked out even in the protaspis. The developmental series of *R. caelatus* and *R. plaesiourus*, and of *R. asperulus* and *R. eximius* are similar to each other, as are the holaspides. Both developmental series and holaspis of *R. caphyroides* are distinctly different.

REMOPLEURIDES CAELATUS n.sp.

Plates 1-3; Plate 4, figures 1-25; Text-figures 4, 5

Holotype. USNM 137675 (Pl. 1, figs. 1, 2), locality 2.

Other Material. Paratypes USNM 137676a-e; all figured specimens in U. S. National Museum.

Geological Horizon and Localities. Edinburg formation, localities 2-4, 6, 7, 15, 16.

Description. Cephalon of outline, excluding librigenal spines, sub-oval, maximum width greater than length (sag.). Glabella of length slightly greater than maximum width, which is across a point about three-fifths the length. Occipital ring widest (sag.) at mid-line, decreasing progressively in width outward, small median tubercle adjacent to occipital furrow. Latter deep medially, rising vertically on anterior side to median glabellar area; distally where it runs along margin of palpebral rim, the occipital furrow is shallow. Median glabellar area gently convex, descending abruptly (especially postero-laterally) to palpebral furrow. Three pairs of lateral glabellar furrows are visible because the exoskeleton is thinner, being excavated on the inner side (Pl. 1, figs. 5, 6). First and second furrows similar in length, curvature of first stronger, directed inward and backward; distal part of first furrow situated in line with maximum width of median glabellar area, furrow becomes wider inward; second furrow distally of similar width to first, but tapering inward; third furrow short, sub-oval in outline, situated in line (exs.) with inner part of first furrow, the three furrows spaced about equidistantly. Glabellar tongue of same width at base as base of median glabellar area, gently convex, widening forward to anterior extremity, across which it is moderately convex; bounded laterally by axial furrow, which is continuous with preglabellar furrow. Latter furrow becomes progressively shallower and closer to anterior margin of tongue as it runs inward, and dies out before reaching mid-line (Pl. 1, fig. 2). In anterior view outline made by anterior margin of preglabellar area is obtusely angulate (Pl. 1, fig. 2).

Eye surface gently convex transversely, moderately convex longitudinally, more strongly curved in posterior than anterior half; external surface with many tiny, low facets arranged in diagonal lines (Pl. 2, fig. 22). Palpebral rim (Pl. 1, figs. 1, 2) widest adjacent to posterolateral part of median glabellar area, narrowing progressively forward to a minimum width where it joins anterior area of free cheek, latter merges with preglabellar area; palpebral rim narrows abruptly as it descends to occipital furrow. Anterior branch of suture runs inward in a curve to mid-line; posterior branch runs beside antero-lateral extremity of occipital ring, then out across cheek just inside posterior margin for a short distance before turning to cut the margin immediately outside the fulcral articulating socket (Pl. 1, fig. 5). Cheek outside eye lobe narrow, outward-sloping, separated from eye surface by convex external rim of eye lobe; broad base of librigenal spine in line (tr.) with posterior part of median glabellar area, spine tapers back to sharp point. Inside base of librigenal spine cheek depressed beside external rim of eye lobe, but outer part convex and extended posteriorly in a rounded projection which lies immediately outside the articulating socket (Pl. 1, fig. 4).

Doublure of cephalon includes that beneath occipital ring and that which extends around free cheek, which is narrow posterolaterally, but widens progressively to the mid-line, where it is crossed by the median suture. At the inner edge, for a short distance on each side of the median suture, there is an upward angulation in the doublure (Pl. 1, fig. 10; Pl. 2, fig. 23). Beneath the eye lobe the innermost part of the doublure is thinner and is curled over, the curled portion being widest anteriorly. The edge of the doublure proximal to the curled part is thick and broad (Pl. 2, fig. 23), this edge being that along which the hypostomal suture runs. In the external surface of the doublure, and lying in the same line (exs.) as the outer end of the hypostomal suture, is a pit (Pl. 1, figs. 10, 11). On the inner surface of the doublure this pit appears as a cone, inclined so that the apex lies close to the angulation in the beginning part of the anterior sutural branch. The apex of the cone is broken in many specimens but appears to have a minute opening at the tip when undamaged (Pl. 2, figs. 23, 24). It seems that the tip rested in a pit in the inner surface of the cranidium, at the junction of the axial and preglabellar furrows, which appear as low ridges on the inner surface (Pl. 2, fig. 25).

Hypostome gently convex, maximum width, across anterior wings, greater than length. Middle body not separated from anterior border by border furrow, but laterally outlined by narrow furrow and posteriorly by broader, shallower furrow. Most of middle body occupied by oval areas, most convex posteriorly, and oriented with long axis diagonal; the exoskeleton over these areas is thinner, so that they are more clearly outlined on the inner surface. The subtriangular strip separating the oval areas is not convex. Median boss short, blunt, backwardly directed. Anterior wing a short, rounded projection of noticeably thinner exoskeleton, lacking a wing process. Inner edge of lateral border a sharp ridge, this ridge continued across postero-lateral border and into base of short, blunt spine; posterior border wider than lateral. Exoskeleton at inturned, upwardly-directed edge of lateral and posterior borders thin, the edges scalloped (Pl. 1, figs. 12-15); in front of the posterolateral projection this exoskeleton crossed by a flexure and part of the inner edge is twisted and projects to form the posterior wing; the edge of the portion along the posterior border displays a broad, deep median notch, outside the edge of which is a small, semicircular notch. The broad, flat anterior edge of the hypostome at the suture is inclined forward medially, twisting to incline back laterally, and thus fits close against the correspondingly inclined surface of the suture on the free cheek (Pl. 1, figs. 11, 12).

Dorsal external surface of exoskeleton, except in furrows, bearing fine raised lines in Bertillon pattern which varies little between individuals. Minute tubercles are also scattered over the surface, and become coarse and readily visible on the glabella adjacent to the palpebral and occipital furrows, and along the posterior edge of the occipital ring. On the doublure and genal spine (upper and lower surfaces) the Bertillon lines run parallel to the margins and heavier terrace lines occur with them. External surface of hypostome bearing lines that run sub-parallel to the margin on the borders, but run longitudinally on the middle body. These lines are stronger than the Bertillon lines of the glabella, and on the borders especially are of equal strength to the terrace lines. Because of the thinness of the exoskeleton over the oval areas the lines are prominent over these areas and help to outline them.

Number of thoracic segments unknown, but eleven is typical for the genus. Axis moderately convex, tapering back, width more than half, and posteriorly three-quarters, of that of thorax. Axial ring sloping forward medially, gently inflated distally, lateral margin semicircular in outline and descending vertically to axial furrow. Narrow articulating furrow and long (sag.) articulating half-ring. Median axial spine (Pl. 2, figs. 11, 12, 18) on fourth segment in front of pygidium (? eighth in thorax) directed backward just above thorax, sharp point extending to, or beyond, tip of pygidium, ventral side flattened, dorsal convex. Inner part of pleura narrow (tr.) in anterior segment, diminishing progressively in width posteriorly. Outer part of pleura gently sloping in anterior segments, slope increasing posteriorly; outline subrectangular in anterior segments, with rounded antero-lateral corner and small point on postero-lateral corner; outline changes progressively posteriorly as outer part of pleura is more backwardly curved and drawn out into a longer point. Fulcral articulating socket and process, and adjacent edges of inner part of pleura, strongly raised; apex of triangular flattened areas of inner part of pleura between them leads into a deep depression immediately in front of, and extending outside of, fulcral socket: this depression appears to constitute the pleural furrow, which dies out rapidly distally. Axial socket and process small. Doublure extends inward to fulcrum, except along posterior edge where a narrow tongue continues inward along outer edge of fulcral articulating socket; doublure is bent upward at inner edge, and inner posterior portion is crossed transversely by a sharp flexure, the vertical portion of the flexure facing posteriorly. Because of this flexure an inner, posterior part of the doublure forms a depression which accommodates the antero-lateral part of the succeeding segment during enrollment. The amount of angular movement possible between the segments is thus limited, and in those following the axial spine it is slight.

Pygidium subrectangular in outline, length greater than width. Convex axis semicircular in outline, width three-quarters that of pygidium at anterior margin, but extending little more than one-quarter of length, divided into two rings. First ring shortest and slightly depressed (sag.) in mid-line, articulating furrow running in curve concave forward; first ring furrow more strongly curved and outline concave posteriorly except distally, where it runs transversely; lobate outer portion descends vertically to axial furrow. Second ring bilobate, with a broad, deep median depression. Articulating furrow deepest distally, articulating half-ring long (sag.). Pleural regions gently convex medially, descending vertically to lateral margins, prominent articulating boss at antero-lateral corner, outside and below which is facet; pleural and interpleural furrows absent, posterior margin drawn out into two pairs of pleural spines, the inner pair the larger. Broad doublure, inner part of which is curved dorsally, so that margin lies immediately ventral to sharp flexure at margin of axis. There is some individual variation displayed by the pygidium — in the degree of inflation of the axis, and particularly in the outline, degree of inflation, and relative length of the inner pair of pleural spines. In the original of Plate 2, figure 14, the inner pleural spines are inflated, separated at the base by a deep cleft, and much longer than the outer pair; in the original of Plate 2, figure 20, the inner spines are relatively shorter and not inflated; in the original of Plate 2, figure 15, though inflated, the inner spines are relatively short and blunt.

External surface of posterior margin and inflated distal part of axial rings of thorax and pygidium tuberculate, less conspicuous tubercles may be scattered over pleural regions. Except in furrows and on articulating half ring Bertillon lines run transversely on axial rings and diagonally on pleurae of thorax, subparallel to margin on pleural region. On median axial spine terrace lines run longitudinally, and stronger ones occur at intervals. Similarly, strong terrace lines run longitudinally on thoracic doublure and subparallel to margins of pygidial doublure.

Development

Protaspis. Two complete and 15 broken specimens of a protaspis from locality 6, and 1 and 6 broken specimens from localities 3 and 4 respectively, have been obtained. This protaspis is exceedingly like that of the closely related younger species *R. plaesiourus.*

Protaspis (Pl. 3, figs. 1-5; Text-fig. 4) subspherical in shape, excluding spines maximum length 0.62 mm., maximum width 0.81 mm., maximum height 0.85 mm. Cephalon and protopygidium subequal in size. Occipital ring of width (tr.) about one-third total width, defined posteriorly by shallow ring furrow, anteriorly by extremely faint occipital furrow, and set off from pleural region by its convexity. Axial furrow in front of occipital ring is indicated by change in slope between gently convex glabella and cheek; axial furrows diverge slightly forwards and run in a straight course to margin. Glabella extends to anterior edge of shield, which is bent down. Pair of tiny tubercles on anterior slope. Fixed cheek gently convex and outward-sloping, palpebral lobe not raised or defined other than by long, curved sutural margin; anterior branch of suture runs from palpebral lobe forward and outward, then curves inward to margin; posterior branch runs in "S" curve and is directed more strongly outward. At anterolateral corner of fixed cheek there is a thick spine directed forward and slightly outward; at posterolateral corner there is a spine of similar size, the fixigenal, directed backward and more strongly outward. There is only the faintest trace of a transverse furrow, directed outward and slightly back, separating fixed cheek from pleural region of protopygidium, and

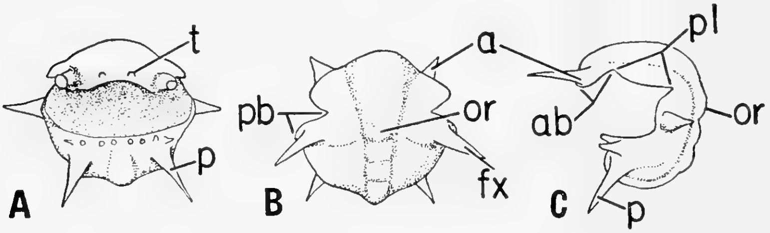

Figure 4. *Remopleurides caelatus* n.sp. A, B, C, protaspis, lacking free cheeks and hypostome, anterior, posterior, and left lateral views, X 26 (compare Pl. 2, figs. 2, 4). Abbreviations: *a,* anterior cephalic spine; *ab,* anterior branch of suture; *fx,* fixigenal spine; *or,* occipital ring; *p,* posterolateral spine on protopygidium; *pb,* posterior branch of suture; *pl,* palpebral lobe; *t,* tubercle.

running out immediately behind the fixigenal spine to reach the margin where it is cut by the extremity of the posterior sutural branch. Free cheek, cephalic doublure, and hypostome unknown. Protopygidium subrhomboidal in outline, well-defined, gently convex axis less than one-third total width, tapering only at blunt tip at posterior margin. In the complete protaspis three axial rings of about equal length (sag.) to the occipital, and a longer tip, may be distinguished. In some broken specimens (Pl. 3, fig. 6) there are five axial rings in front of the tip. Pleural region slopes gently to lateral margin, but posterolaterally and beside tip of axis is bent down vertically, prominent spine at posterolateral corner is situated at upper edge of this flexure. Doublure narrow and curled under, tiny median notch, greatest width posterolaterally, diminishing in width anteriorly to disappear at anterolateral corner. Along posterior margin of pygidium, behind main pleural spines, are 4 pairs of tiny spines, the middle pair close together at base of notch in doublure, the outer pair largest, and directly behind main spines.

Degree 0. Reconstructed (Text-fig. 5) from the smallest cranidia, free cheeks and transitory pygidia (Pl. 3, figs. 7-15, 17, 18), all of which are like those of the younger species *R. plaesiourus*. Cranidia are known from localities 3, 4, and 6, free cheeks from 3 and 4, transitory pygidia from 2-4, 6, 7, 15, and 16.

Differs from protaspis most obviously in better definition and subdivision of axial region, in reduction of fixigenal spine to a small nub, and absence of main posterolateral spines on transitory pygidium. The longitudinal convexity of the cephalon is such that, if the posterior margin of the occipital ring is oriented in the vertical plane, then the anterior slope of the glabella is vertical. The longitudinal convexity of the transitory pygidium and inclination of the articulating half ring is such that the position relative to the cephalon gives a subspherical shape to the exoskeleton. In several specimens a pair of small tubercles may be seen on the glabella, situated in line with the bases of the anterior cranidial spines and near the ill-defined glabellar margin. Palpebral lobe slightly raised above adjacent part of fixed cheek, notably posteriorly, where the angle the margin makes with the posterior sutural branch is more acute and more deeply indented than in the protaspis. Some specimens suggest the presence of a faint, narrow palpebral rim. Free cheeks of smallest size (Pl. 3, figs. 17, 18) fit approximately, and are separated by median suture. The anterior branch of the suture has the characteristic curve so that the dorsal surface of free cheek narrows and disappears at mid-line. Outside eye lobe free cheek of uniform width and lateral outline consequently a convex curve; librigenal spine arises from border at a point opposite two-thirds the length (exs.) of the eye lobe, is broad at the base and tapering. Projection from inner part of posterior border of free cheek not developed. Eye surface narrow (tr.), facets relatively large, about 8 in a diagonal row. Doublure relatively broad in front of librigenal spine, narrow behind, inner margin excavated in broad curve along hypostomal suture, pit in doublure adjacent to extremity of this suture, pit appearing on inner surface as low, blunt cone.

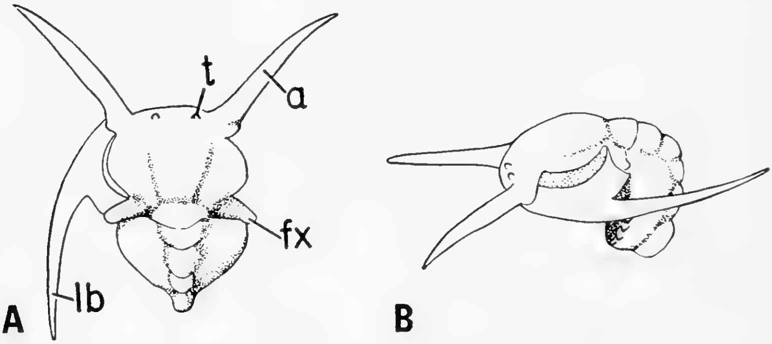

Figure 5. *Remopleurides caelatus* n.sp. Outline reconstruction of degree 0 individual, right free cheek omitted. A, exterior, B, oblique exterior view, X 26. Abbreviations: *a*, anterior cephalic spine; *fx*, greatly reduced fixigenal spine; *lb*, librigenal spine; *t*, tubercle. Based on originals of Plate 3, figures 9, 12.

Hypostome unknown.

Transitory pygidium subcircular in outline, strongly convex (sag. and tr.), most strongly so posteriorly. Width of axis about one-quarter maximum width of transitory pygidium, gently convex in anterior part, which is divided by furrows into a prominent articulating half-ring and five axial rings. Rings decrease in length and width posteriorly, the fifth markedly shorter than those in front of it; posterior part of axis strongly convex, undivided, tip steeply sloping. Four pairs of short spines along postero-lateral margin of pleural regions, doublure narrow, curled.

Comparison of this transitory pygidium with the protopygidium of the protaspis shows the strong resemblance in outline and form between the two. Chief changes are the more convex axis, better definition of rings, and lack of main pleural spines in degree 0.

Further development of cephalon. Cranidia of length (sag.) 0.85 (Pl. 4, figs. 1, 2) to 0.97 mm. (Pl. 3, fig. 16) from localities 2, 6, 15 seem to represent the next stage of growth. Occipital ring is wider (tr.) than the glabella between the posterior part of the palpebral lobes, moderately convex; large low median tubercle close to anterior margin, row of 12 blunt spines evenly spaced along posterior edge. Occipital furrow with vertical anterior slope so that glabella adjacent to occipital ring stands higher than ring; glabella outlined by its convexity and by shallow axial furrows, expands forwards to maximum width (equal to that of occipital ring) opposite anterior part of palpebral lobe, is pinched-in opposite anterior end of palpebral lobe, then expands forward again to equal greatest width at margin of tongue. Latter is bounded laterally by narrow band of fixed cheek and deep axial furrow, there is no anterior cranidial spine; anterior edge of tongue with evenly curved outline and narrow preglabellar field laterally, which narrows almost to disappearance as mid-line is approached. Palpebral lobe with broad, gently convex rim which is widest posterolaterally and narrows forward; between rim and axial furrow is a small, crescentic flat area situated in the inner, anterior portion of the lobe. Free cheek like that of degree 0.

By the time the cranidium reaches a length (sag.) of about 1.24 mm. (Pl. 4, figs. 7, 8) the glabella has expanded between the palpebral lobes so that the earlier flat part of these lobes is eliminated, and the lateral margin of the glabella is separated from the palpebral rim by a palpebral furrow. This furrow is broadest at its mid-point, and in line with this point is the maximum glabellar width, which is greater than that of the tongue or the occipital ring. Beyond this size there is no major change in morphology of the cranidium. As size increases, convexity of the glabella increases, both longitudinally and transversely, and the axial-palpebral furrow becomes narrow and deep, with a vertical slope down from the glabella. Three pairs of muscle scars have been observed on glabella of cranidia of length (sag.) 2.5 mm. and upwards. Small tubercles occur on the external surface of the tongue and on the glabella adjacent to the palpebral furrow in cranidia of this same size, the raised lines appearing at a larger size. Free cheek that fits a cranidium of length (sag.) about 1.2 mm. (Pl. 4, figs. 11, 12) essentially like the largest, with narrow region outside eye lobe, doublure with pit, strong terrace lines and inner edge curled. Hypostomes of the smallest size known (Pl. 4, figs. 3, 4) fit a cranidium of length (sag.) 2.5 mm., and differ from the largest in that the spine on the posterolateral corner is longer.

Thorax and pygidium. Transitory pygidia from localities 3 and 4 are tentatively placed here. Tiny specimens of this type have not been recovered from localities 2, 6, or 15. Earliest in the presumed series are those having a length (sag., excluding spines) of 0.37 to 0.44 mm. (Pl. 4, figs. 5, 6, 13, 16-18, 22), and bearing a prominent upwardly-curving median axial spine of length almost 2 mm. The axis is convex, three-fifths the total width, not sharply bounded from the less steeply-sloping pleural regions. Three pairs of thornlike pleural spines are about equally spaced along the lateral and posterolateral margins, and between the last pair, on the posterior margin, there may be a tiny fourth pair (Pl. 4, fig. 5). The doublure is narrow and curled under, with a median posterior notch. The axis is crossed by broad, shallow ring furrows, the rings gently convex, and in front of the swollen base of the median spine there may be two rings (Pl. 4, figs. 5, 6, 13), one ring (Pl. 4, figs. 16-18), or none (Pl. 4, fig. 22). In all there is a shallow articulating furrow and an articulating half-ring. In those with the median spine at the anterior end of the axis, axial rings cannot be seen behind the base of the spine. In the holaspis (Pl. 2, fig. 12) the median axial spine is on the 4th segment in front of the pygidium, i.e.

the 8th thoracic segment if the total number is eleven. On this assumption the transitory pygidia with 2, 1 and no rings in front of the axial spine would be, respectively, those of degrees 5, 6, and 7. Specimens belonging to any one of these degrees vary in size within the limits mentioned. Those of degree 5 seem always to exhibit the fourth pair of pleural spines, but those of degrees 6 and 7 may, or may not, possess them. These transitory pygidia are similar to those described by Ross (1951, pp. 582-3, pl. 83, fig. 19; 1953, p. 634, pl. 62, fig. 20) as belonging to an older remopleuridid species.

The second group of transitory pygidia (Pl. 4, figs. 23-25) vary from 0.3 to 0.4 mm. in length (sag., excluding spines and articulating half-ring). The convex axis tapers backward and extends close to the posterior border. Up to four rings may be outlined by shallow ring furrows, the articulating furrow and anterior ring furrow being the deepest, those following being progressively shallower and the rings shorter (sag. and exs.). The third ring may show a faint median longitudinal depression, like those on the rings of the holaspid pygidium, and the fourth ring may be bilobate. Pleural regions narrow, less steeply sloping, lateral and posterolateral borders bearing triangular spines. These spines are differently developed on different specimens (probably corresponding to different degrees) — three pairs subequal in size and a tiny fourth posterior pair (Pl. 4, fig. 24), three subequal pairs (Pl. 4, fig. 25), or three pairs with the third small (Pl. 4, fig. 23). The doublure is curled under and bears the prominent terrace lines. Since these transitory pygidia bear no trace of the median axial spine, it seems likely that they belong to degrees 8-10, i.e. those succeeding the release of the spine bearing segment into the thorax. If they belonged to early degrees (1 to 4) they might be expected to show some sign of the median axial spine, unless this spine appears abruptly between moults. Further, the tip of the axis of the degree 0 transitory pygidium is strongly convex, quite unlike that of this type.

The smallest pygidia that are probably those of the holaspid (Pl. 4, fig. 21) are about 0.49 mm. in length (sag.), and are similar to larger specimens.

REMOPLEURIDES PLAESIOURUS n.sp.

Plate 4, figures 26-30; Plate 5; Plate 6, figures 1-15.

Holotype. USNM 137677 (Pl. 5, figs. 3-5), locality 9.

Other Material. Paratypes USNM 137678a-e; all figured specimens in U.S. National Museum.

Geological Horizon and Localities. Lower Martinsburg shale, localities 9, 10, 12.

Description. This species is exceedingly like *R. caelatus* n.sp., differing from it in minor details of outlines, convexities, and proportions of parts of the exoskeleton. Comparisons between the photographs show that in *R. plaesiourus:*

a) glabellar tongue (compare Pl. 5, figs. 3, 4 with Pl. 1, figs. 3, 8) appears relatively narrower, is more inflated so that the slope down to the axial furrow is vertical, and the anterior area of fixed cheek is slightly wider. The preglabellar area dies out well before reaching the mid-line; in exterior view the outline of the anterior margin of the preglabellar area is almost straight, rather than obtusely angulate;

b) outline of palpebral rim in dorsal view (compare Pl. 5, fig. 5, with Pl. 1, fig. 5) is less curved in anterior half, more curved in posterior half, and the rim itself is wider (exs.) immediately in front of the occipital ring;

c) the different shape of the tongue and palpebral rim means that slight differences in shape are also present in the free cheek (compare Pl. 5, figs. 6, 7, with Pl. 1, figs. 4, 16) — in the outline of the inner margin of the eye surface and the course of the anterior branch of the suture. In addition, the librigenal spine is differently placed, and there is a deeper and wider notch between the base of the spine and the posterolateral part of the cheek;

d) the hypostome (compare Pl. 4, figs. 26, 29, 30 with Pl. 1, figs. 9-15) has a different outline, the anterior margin less strongly curved, the posterolateral part of the border slopes more steeply, the median boss is higher and sharper, the oval areas less inflated posteriorly;

e) the pygidium (compare Pl. 5, figs. 8, 9, 12-15 with Pl. 2, figs. 14-17, 19-21) shows the same kind of individual variation as that seen in *R. caelatus* in the relative length and amount of inflation of the inner pleural spine. Yet the inner pair of spines is relatively wider at the base and longer; the lateral margins of the pygidium are parallel-sided rather than backward converging and a low but distinct post-axial ridge is present, extending about half-way to the base of the notch between the inner pleural spines;

f) pattern of Bertillon lines on cranidium (compare Pl. 5, fig. 1 with Pl. 1, fig. 1) is different, and there are more granules in the mid-region of the median glabellar area. Median region of pygidium is also more granulate (compare Pl. 5, fig. 15 with Pl. 2, fig. 19).

Development. The development of *Remopleurides plaesiourus* is so like that of *R. caelatus* that much of the description given of the latter would apply to both species. The material of *R. plaesiourus* is less abundant and less complete in some respects. The protaspis (Pl. 5, figs. 18-20, 26) is broken at the anterolateral corners, so that the anterior cephalic spines are not seen. The protopygidium shows five axial rings, the fifth faint, in front of the convex tip of the axis, as do some broken specimens of *R. caelatus* (Pl. 3, fig. 6). In other respects the protaspides of the two species are alike.

The degree 0 cranidium of *R. plaesiourus* has slimmer anterior cephalic spines and the outline of the palpebral lobe is typical of this species in being more strongly curved posteriorly (compare Pl. 5, fig. 16, with Pl. 3, fig. 9). The transitory pygidium of degree 0 (Pl. 5, figs. 21-23) is like that of *R. caelatus*, and the few specimens show a small range in size.

A cranidium of length (sag.) 0.75 mm. (Pl. 6, fig. 1) shows a stage not found in the material of *R. caelatus* n.sp. It is very little larger than the degree 0 cranidium, the palpebral lobe has a faint rim, and the anterolateral margin continues the line of the anterior palpebral margin forward to meet the transverse anterior margin at an obtuse angle. Anterior cephalic spines are lacking, and the symmetrical form (three additional specimens are known from locality 10) suggests that the shape is not the result of breakage but of the inward shift of the anterior branch of the suture following the loss of the spine.

The next largest cranidium, of length (sag.) 0.79 mm. (Pl. 6, fig. 3) has the tongue with steeply sloping sides, and the anterior area of the free cheek. The glabella is narrowest in front of the occipital furrow and expands forward at an even rate to the maximum width at the anterior end of the tongue. The palpebral lobe has a well-developed rim, broadest posteriorly, and enclosed between the arc of the palpebral furrow and the straight axial furrow is a horizontal area. This area is larger than that in cranidia of the same size of *R. caelatus* (Pl. 4, figs. 1, 2) because in this latter specimen the glabella expands toward the mid-length of the eye lobes. The free cheek fitting the small cranidium of *R. plaesiourus* (Pl. 6, fig. 4) has the curve of the inner margin of the visual surface, and deep notch between base of spine and lateral margin, characteristic of this species (compare with that of *R. caelatus*; Pl. 3, fig. 16).

In the next two larger cranidia (Pl. 6, figs. 2, 5, 7, the original of fig. 5 of length (sag.) 1.27 mm.), the glabella bulges out between the eye lobes, and in larger cranidia (Pl. 6, figs. 8-12, 15) occupies the space between the palpebral furrows. From this size onwards there is little further change.

Transitory pygidia between degree 0 and probable degrees 8-10 are not known in *R. plaesiourus*, but those of degrees 8-10? (Pl. 5, figs. 24, 25) bear three pairs of marginal spines and are like those of *R. caelatus*.

REMOPLEURIDES CAPHYROIDES n. sp.

Plates 7-10; Plate 11, figures 1-4; Text-figure 6

Holotype. USNM 137681 (Pl. 7, figs. 1-3, 8, 10; Pl. 8, figs. 8, 10), locality 3.

Other Material. Paratypes USNM 137682a-e; all figured specimens in U. S. National Museum.

Geological Horizon and Localities. Edinburg formation, localities 2-6, 15. Fairly common at localities 2-4, rare at the others, especially at 6, where *R. caelatus* is common.

Description. All parts of the exoskeleton of this species may be differentiated from those of *Remopleurides caelatus* by the following characters:

(i) Glabella (compare Pl. 7, figs. 1-3 with Pl. 1, figs. 1-3, 5, 8) is more convex (sag. and tr.), especially anteriorly, and the relatively wider and more inflated tongue overhangs the anterior cephalic margin; palpebral rim is narrower in anterior part, and anterior area of fixed cheek is narrower. Outline of anterior edge of cranidium a curve, concave (rather than convex) ventrally. The two posterior glabellar furrows are faintly visible as curved, smooth strips, and the short anterior furrow is rarely visible (compare Pl. 7, figs. 3, 8 with Pl. 1, figs. 5, 6); all the furrows are less conspicuous than in *R. caelatus.* Posterior area of fixed cheek short (exs.) and narrow (tr.), the anterior margin a gentle "S" curve.

(ii) Free cheek (compare Pl. 7, figs. 1, 3-7, 9, 10 with Pl. 1, figs. 4, 10-12, 16) with anterior part of eye surface overhanging margin, external rim of eye lobe less conspicuous; doublure adjacent to median suture wider (sag. and exs.) and with more curved anterior margin; posterior margin outside suture curves gently forward to base of librigenal spine — there is no posteriorly directed projection outside the articulating socket, and the base of the librigenal spine is broader and the spine is differently directed. As in *R. caelatus* there is a pit in the doublure, appearing on the inner surface as a long, slim cone, the tip of which rests in a pit at the junction of the axial and preglabellar furrows (compare Pl. 8, figs. 8-10 with Pl. 2, figs. 23-25).

(iii) Hypostome (compare Pl. 7, figs. 4, 5, 7, 9 with Pl. 1, figs. 9-15) strikingly different, being transversely rectangular in outline with wider borders, prominent shoulder and posterolateral projection. Middle body separated from anterior border by shallow furrow, the oval areas with the long axis more widely divergent and enclosing a larger triangular area; on the anterior margin in the mid-line is a low rounded median boss. Anterior wing long and slim, no wing process, curving forward and upward so that distally it lies above the curled edge of the free cheek doublure. Posterior wing a large blunt projection.

(iv) Thoracic segments (compare Pl. 9, figs. 1-5, 7, 8, 12 with Pl. 2, figs. 1-13, 18, 19) have distal parts of axial rings only gently convex, less prominent axial articulating processes and sockets, longer (exs.) and wider (tr.) pleurae, flattened and tapering more gradually. The median spine on the eighth (?) thoracic segment is relatively slimmer and shorter.

(v) Pygidium (compare Pl. 9, figs. 6, 9-11, with Pl. 2, figs. 11-13, 18-21) lacks ring furrow defining median part of first axial ring, and pleural regions flattened, broadest at mid-length, bearing two pairs of border spines of which the outer are the longer.

(vi) External surface of glabella granulate in mid-part of median area (Pl. 7, fig. 3), with a row of larger granules along the posterior margin of the occipital ring in all but largest individuals (Pl. 8, figs. 1, 3, 5). Bertillon lines present on anterior and anterolateral parts of glabella (Pl. 7, figs. 1, 2) but not as conspicuous as in *R. caelatus.* On free cheek and hypostome, terrace lines run sub-parallel to margins. On axial rings of thorax, lines run transversely and there may be a row of granules along the posterior margin. On dorsal surface of pleural spines of thorax and pygidium each terrace line runs in a characteristic inverted "V" course (Pl. 9, figs. 3, 5, 6, 9, 12), and on the doublure the lines run sub-parallel to the lateral margins (Pl. 9, figs. 2, 4, 8, 11).

The cranidium, free cheek and hypostome have been associated by fitting together isolated specimens (Pl. 7; Pl. 8, fig. 7). The form of the occipital ring leads to association of the thoracic segments, and the pleurae of the latter may be matched in form and lines on external surface with pleural regions of the pygidium (Pl. 9, figs. 1-12).

Development

The supposed developmental series of *Remopleurides caphyroides* is illustrated in Plate 10 and Plate 11, figures 1-3. There is no complete size series of cranidia below a length of 1.7 mm. from any one locality. In this range, therefore, the series is tentative, being built up from specimens from different localities. The development of the cranidium will be described in descending order of size and the arguments given for the series here advocated. Cranidia of length (sag.) 2.5 mm. (Pl. 8, figs. 5, 6) (or larger) down to 1.73 mm. (Pl. 10, figs. 1-4) show a gradual transition — in the smallest example the glabella is relatively narrower, in longitudinal profile seen to be more convex and strongly arched at the base of the tongue, the anterior outline a rounded, inverted 'V' rather than a broad curve; the palpebral lobe is relatively wider (tr. and exs.), especially in the posterior part; external surface more coarsely granulate. A free cheek that approximately fits this cranidium is much like larger ones; smaller specimens are not known.

The next smallest cranidium comparable to the original of Plate 10, figures 1-4, is the original of Plate 10, figures 5-7, 0.92 mm. in length (sag.). The anterior part of the glabella has the same inverted 'V' outline in dorsal view and is more strongly raised, coming up to a blunt point in the mid-line at the base of the glabellar tongue; between the median part of the palpebral lobes the glabella is much narrower, the sides diverging forwards; a short basal glabellar furrow opposite the posterior part of the palpebral lobe, a longer median furrow opposite the middle part of the palpebral lobe — comparable positions to those of the furrows in larger glabellae. The palpebral lobe is subsemicircular in outine, horizontal, and with a faint rim.

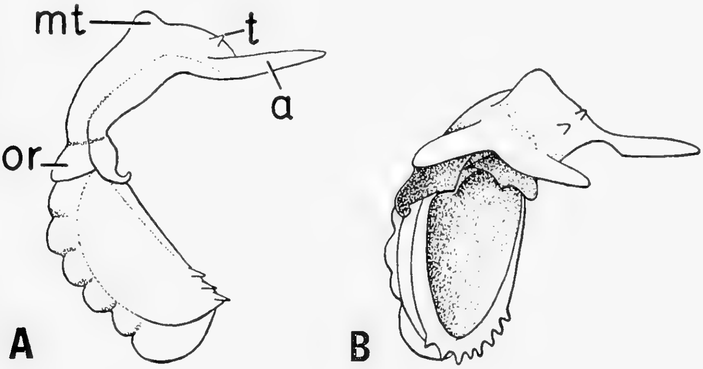

Figure 6. *Remopleurides caphyroides* n.sp. Outline reconstructions of degree 0 individual, lacking free cheeks and hypostome. A, right lateral, B, oblique views, X 30. Abbreviations: *a*, anterior cephalic spine; *mt*, median tubercle of glabella; *or*, occipital ring; *t*, tubercle. Based on originals of Plate 10, figures 8-14, 16, 17.

It seems reasonable to suggest that the preceding stage of the cranidium (believed to be degree 0 by analogy with *R. caelatus*) is that shown in Plate 10, figures 8-11, 13 (cf. Text-fig. 6) with the striking large median glabellar tubercle situated opposite the anterior end of the palpebral lobes. The occipital ring is relatively narrow, the glabella straight-sided and expanding forward; two pairs of smooth areas are the lateral glabellar furrows, situated in the same relative position as in the next larger cranidium; about mid-way down the anterior slope is a pair of tiny tubercles. Anterior cephalic spines are long and curved, and there is a slight swelling at the tip of the posterior area of the fixed cheek suggesting a fixigenal spine; palpebral lobe gently convex and outward sloping, narrow rim. External surface granulate, prominent median occipital tubercle.

The protaspis preceding this degree 0 cranidium can hardly be other than that shown in Plate 10, figures 15, 18-20, and Plate 11, figures 1-4, the cranidium differing in its greater longitudinal convexity, and in exhibiting slim fixigenal spines. This protaspis differs from that of *Remopleurides caelatus* (Pl. 3, figs. 1-5) in the more elongate outline of the cranidium and protopygidium, the more convex glabella, which is not only more convex anteriorly but has the large median tubercle; narrow palpebral rim, anterior branches of the suture directed slightly inwards. The three pairs of spines — anterior cephalic, fixigenal, and protopygidial — are slimmer than those of *R. caelatus*. Protopygidium with five axial rings in front of terminal portion and four pairs of tiny spines on the posterior margin, as in *R. caelatus*. Division between cephalon and protopygidium more clearly shown by shallow furrow that curves outward and backward from beside the posterior margin of the occipital ring and passes just behind the fixigenal spine.

The degree 0 cranidium of *R. caphyroides* (Pl. 10, figs. 8-11, 13) is also distinguished from that of *R. caelatus* (Pl. 3, figs. 7, 9) by the outline, median glabellar tubercle, narrow palpebral rim, and slimmer anterior cephalic spines. The degree 0 transitory pygidium here referred to *R. caphyroides* (Pl. 10, figs. 12, 14, 16, 17) is extremely like that of *R. caelatus* (Pl. 3, figs. 8, 10-15), differing in being larger and relatively longer, the outline being suboval rather than subcircular. These two transitory pygidia occur together at localities 2, 3, and 4, but can be separated by size (though each type shows some range in size) and outline, especially at locality 2 where both species are common. At locality 6, where *R. caphyroides* is extremely rare, the transitory pygidia are all of *R. caelatus* type. It may be added that the degree 0 transitory pygidium of *R. placsiourus* (Pl. 5, figs. 21-23) is of the same size and outline as that of the closely related *R. caelatus*.

Comparison between the protaspides of *R. caphyroides* (Pl. 10, figs. 15, 18-20; Pl. 11, figs. 1-3) and *R. caelatus* (Pl. 3, figs. 1-6) shows that the outlines and size of the protopygidia differ in the same way as do the degree 0 transitory pygidia. The degree 0 transitory pygidium of *R. caelatus* is smaller than the protopygidium of the protaspis of *R. caphyroides,* whereas the degree 0 transitory pygidium referred to *R. caphyroides* is larger.

Small hypostomes of *R. caphyroides* (Pl. 9, figs. 16, 17) differ from the largest in the more square outline, greater convexity of the middle body, the presence of a blunt median spine (rather than boss) and a spine at the posterolateral angle.

The smallest known pygidium of *R. caphyroides* (Pl. 9, figs. 18, 22) is 0.52 mm. in length and does not seem to be transitory — it differs from larger ones in that the inner pair of pleural spines is close together and partly fused. The degree 0 transitory pygidia of *R. caphyroides* and *R. caelatus* are similar, but there seems no reason to believe that the transitory pygidia of *R. caelatus* with the long median axial spine (Pl. 4, figs. 5, 6, 13, 16-18, 22) may belong to *R. caphyroides* — the latter species does not have such a prominent median axial spine in the holaspid thorax and the shape of the pleural regions is different.

The material described above has been found at the following localities: protaspis, localities 2-5; degree 0, localities 2, 3 (transitory pygidium only), 4, 6, and 15 (cranidium only); parts of larger exoskeletons are relatively abundant at localities 2 and 3, few at localities 4, 6, and 15, and unknown from 5. From localities 3 and 4 come cranidia of length (sag.) 1.3 mm. (Pl. 11, figs. 5-8) which in size and other characters are intermediate between the originals of Plate 10, figures 1-4 and 5-7 — in outline of glabella between palpebral lobes, in form of lateral glabellar furrows, and size of papebral lobe. The anterior part of the glabella, however, has a broadly rounded outline in dorsal aspect, and in lateral aspect lacks the sharp convexity. Further, and also only from localities 3 and 4, comes a degree 0 cranidium (Pl. 11, figs. 9-11) like the original of Plate 10, figures 8-11, 13, except that it lacks the large, rounded median tubercle on the anterior part of the glabella. No protaspis of this type is known. Two possible explanations occur for these cranidia: (a) they are part of the developmental series of an otherwise unknown species of

Remopleurides, or (b) they are part of the *R. caphyroides* developmental series. Acceptance of the latter alternative would mean that in the early meraspid development of the cranidium of some individuals the median glabellar tubercle was abruptly reduced between protaspis and degree 0 and the glabellar tongue consequently rounded in dorsal outline. I know of no comparable case of morphological differences between groups of early meraspides of a single species.

REMOPLEURIDES ASPERULUS n.sp.

Plates 12, 13.

Holotype. USNM 137683 (Pl. 12, figs. 1, 2, 4, 6, 14), locality 13.

Other Material. Paratypes USNM 137684 a-c; all figured specimens in U. S. National Museum.

Geological Horizon and Localities. Upper Lincolnshire limestone, localities 1a, 13.

Description. This species is the only remopleuridid in the upper Lincolnshire limestone, and the first to appear in the Middle Ordovician of the Shenandoah valley. The silicification is relatively coarse-grained, and the surfaces of most of the specimens have granules (probably of quartz) adhering to them or growing out of them. A fairly complete growth series is known.

Cranidium (Pl. 12, figs. 1, 2, 4, 6, 14) wider than long, maximum width at the mid-length, the margin of the palpebral lobe projecting farther out than the tip of the posterior area of the fixed cheek. Free cheek (Pl. 12, figs. 3, 5, 11, 20) correspondingly narrow, the convex eye surface overhanging the margin anterolaterally, the postero-lateral portion, outside the external rim of the eye lobe, narrow, triangular, steeply sloping, with a blunt, short librigenal spine. Occipital ring moderately convex, longest (sag.) in the mid-line, deep, narrow occipital furrow. Remainder of glabella evenly and moderately convex (tr. and sag.), outlined by narrow palpebral and axial furrows; glabellar tongue two-fifths maximum width of cranidium, bent down steeply to overhang slightly anterior margin of cephalon. Glabellar furrows visible on inner surface as grooves (Pl. 12, fig. 14), basal furrow long, curved, opposite greatest width of glabella, second furrow shorter, curved, opposite a point about one-third length of palpebral lobe. Palpebral lobe widest posteriorly, narrowing progressively forward and continuous with extremely narrow anterior area of fixed cheek. Doublure of cephalon widest anteriorly; beside median suture a narrow posterior portion is flexed up vertically and then bent back horizontally (Pl. 12, fig. 3) — this flexure dying out rapidly away from the median suture; anterolaterally doublure curled up at inner edge, and extending back to where the suture cuts posterior cephalic margin. Pit in doublure (Pl. 12, fig. 11) appearing as a long, slim cone on inner surface (Pl. 12, fig. 3); tip of cone lies close to anterior pit. Hypostome (Pl. 12, figs. 7, 8, 12) subrectangular in outline, wider than long, middle body with prominent median boss and diagonally directed oval areas; borders broad, blunt spine at posterolateral angle, anterior wing short, posterior wing small.

Thorax of at least nine segments (Pl. 12, figs. 15-18). Axis broad, two-thirds width of segments, pleurae steeply sloping, with short pleural spines except for long spine on fifth segment from posterior. Short, blunt median axial spine on fourth segment from posterior. Prominent axial articulating processes and sockets. Doublure extends in to axial furrow, posterior part crossed by a sharp, curving and transversely directed flexure which borders a depressed (in ventral view) posterior area that receives the anterior part of the succeeding segment during enrollment (see Pl. 12, fig. 17, anterior segments on left side). Pygidium (Pl. 12, figs. 15-18) wider than long, broad, short axis tapers rapidly to rounded termination, first axial ring narrow (sag.) medially and expanding laterally into a lobate area, second axial ring bilobate and lying between outer parts of first ring. Steeply sloping pleural regions having two pairs of short, blunt, posteriorly directed spines, deep notch between inner pair, smaller notch between the pairs. Doublure broad, bent upwards, median posterior projection.

External surface bearing anastomosing terrace lines — on cheek (Pl. 12, fig. 20) running sub-parallel to margins, on thorax and pygidium (Pl. 12, fig. 15) transversely on axis, on pleurae curving distally to run subparallel to long axis. Along posterior margin of axial rings a row of low tubercles, largest laterally. On doublure (Pl. 12, figs. 11, 17) terrace lines strong and everywhere subparallel to inner margin; on hypostome lines run diagonally on middle body, and along the borders.

Development

Protaspis (Pl. 13, figs. 1-4, 10). Subspherical in shape, convex cranidium with protopygidium curled closely beneath it. Owing to the coarse grain of the replacement, details cannot be observed. The axis is not defined. In lateral view scalloped lateral margin of cranidium shows position of palpebral lobe and course of anterior branch of suture. A second incomplete specimen (not illustrated) shows four pairs of tiny spines along the curled posterior margin of the protopygidium, and a larger pair of spines on the steep flanks in front of the outermost marginal pair. Anterior cephalic spines are either absent or not preserved. What may be the fixigenal spine is visible a short distance inward and backward from the base of the palpebral lobe.

Degree 0 (Pl. 13, figs. 5-7). Cranidium believed to be this degree, of length 0.83 mm., gently convex transversely, strongly convex longitudinally so that short (sag.) glabellar tongue descends vertically. Maximum width of cranidium at about half length and almost same as length (sag.), palpebral margin projects out farther than posterior area of fixed cheek. Occipital ring is well-defined, convex, width about one-third that of cranidium, with median tubercle, and in front of it axial furrows extend directly forward a short distance, outlining the gently convex posterior part of the glabella, and then die out. One specimen (not illustrated) suggests that a short anterior cephalic spine is present; fixigenal spine absent. External surface granulate.

Transitory pygidium (Pl. 13, figs. 11-15) of length ca. 0.9 mm., maximum width four-fifths of length; at three-quarters the length high and strongly convex so that lateral and posterior slopes are vertical, maximum convexity and height at point of greatest width. Axis about one-third total width, with prominent articulating half ring; six gently convex rings progressively shorter (sag.) posteriorly, and a more convex semi-cylindrical posterior portion situated on the posterior slope. Each ring is separated from the others and the posterior portion by a faint ring furrow, and there is a stronger articulating furrow, but axial furrows as such are not present. Doublure is present around postero-lateral margins, curled under, and along the curled edge is a curving row of 5 spines, the innermost pair close together on the ventrally-facing surface of the doublure immediately behind the tip of the axis, the other spines evenly spaced along the pleural margins. External surface finely granulate, the granules present on the axial rings but not in the furrows. On the posterior parts of the pleural regions curving granulated bands, separated by narrow smooth bands (Pl. 13, fig. 14), run out from the last 3 rings to the pleural margin. Each of these bands ends against the base of a marginal spine, and the second, third and fourth pairs seem thus to belong to the three axial rings in front of the terminal axial portion.

Further Development. The next smallest cephalon (Pl. 13, fig. 17), cranidium of length (sag.) 1.0 mm., has the axial furrow visible as a change in slope between glabella and palpebral lobe, extending forward from the margin of the occipital ring to the edge of the tongue in a curve gently convex outward. Glabellar tongue is curved gently downward, width about half maximum width of cranidium. Palpebral lobe is gently convex, rim distinct and widest posteriorly. Free cheek with long, slim librigenal spine. At the next size known (Pl. 13, figs. 20-22, cranidium of length 1.4 mm.) the glabella extends between the palpebral furrows and is gently and evenly convex transversely. Width (tr.) of tongue is more than half maximum width of cranidium. As size of cephalon increases (Pl. 13, figs. 23-31), the major changes that take place are relative increase in maximum width of cranidium so that it becomes greater than length, and this is accompanied by increase in curvature of the palpebral rim in dorsal view, and steeper down-bending of glabellar tongue so that the tongue becomes barely visible in dorsal view. The librigenal spine is progressively reduced to a blunt, short point. Granulation on the external surface becomes relatively finer, and can scarcely be seen in the larger specimens, partly owing to the preservation. Glabellar furrows are faint or invisible in most specimens, an exception being the original of Plate 13, figures 24-26, in which the furrows are represented by shallow grooves in the external surface.

Smallest hypostome known (Pl. 13, figs. 8, 9) differs from largest principally in having a longer posterolateral spine.

An example of the transitory pygidium (Pl. 13, figs. 16, 18, 19) probably belongs to the later degrees of the meraspid period.

The first ring of the broad axis is continuous with the posteriorly directed spinose pleura, and the articulating half ring and process is typical. Behind and inside this segment the next ring is demarcated, and there are two pairs of pleural spines; between the median pair of spines is the deep notch characteristic of the holaspis.

REMOPLEURIDES EXIMIUS n.sp.

Plates 14, 15, 16.

Holotype. USNM 137685 (Pl. 14; Pl. 15, fig. 1), locality 4.

Other Material. Paratypes, USNM 137686a, b; all figured specimens in U. S. National Museum.

Geological Horizon and Locality. Lower Edinburg limestone, localities 3 and 4. One specimen of the degree 0 transitory pygidium attributed to this species comes from locality 2.

Description. The holotype specimen is an exceptionally complete exoskeleton lacking only the right free cheek and the hypostome. Only a few other exoskeletal parts come from locality 4, but these include the hypostome. At locality 3 this species is less common than *Remopleurides caphyroides* n.sp. and about as abundant as *R. simulus* n.sp. *R. eximius* n.sp. resembles closely *R. asperulus* n.sp. from the Upper Lincolnshire limestone, and it is largely because of this similarity that a hypostome occurring at localities 3 and 4 has been attributed to it. *R. eximius* may be distinguished from *R. asperulus* by the following characters: —

Glabellar tongue (compare Pl. 15, fig. 1 with Pl. 12, fig. 4) of width (tr.) about half that of glabella, palpebral rim narrower posteriorly and outline in dorsal aspect evenly curved rather than a markedly stronger curvature in the posterior part. Free cheek extremely similar, but having a different curvature of the eye lobe and a more marked depressed region in the posterior part of the doublure. This depressed region receives the facet of anterior thoracic pleura during enrollment (Pl. 14, fig. 2). Hypostome (compare Pl. 15, figs. 2, 4, 10 with Pl. 12, figs. 7, 8, 12) differs from that of *R. asperulus* in details of outline and in having a larger shoulder.

Thorax (Pl. 14; Pl. 15, figs. 6-8, 11, 12) of 11 segments, a longer pleural spine on the seventh and a median axial spine on the eighth. Pygidium (compare Pl. 15, figs. 9, 13, 14 with Pl. 12, figs. 15, 16, 18) distinguished by the convexity of the axis and consequent depth of furrows, including the median longitudinal; posterior notch between inner pair of pleural spines broader.

Development of *Remopleurides eximius* n.sp. ?

Protaspis. A distinctive protaspis (Pl. 16, figs. 1-7, 9), quite abundant at locality 3 but also present at locality 4, has been attributed to this species because of its resemblance to that of *Remopleurides asperulus* n.sp. This protaspis is far better preserved than that of *R. asperulus,* though in neither case is the free cheek or hypostome known. Cranidial portion evenly convex (sag. and tr.), the occipital ring (Pl. 16, fig. 2) faintly outlined by both occipital and axial furrows and width of about one-third that of the cranidial portion. Conspicuous pair of tubercles close to mid-line and situated near anterior margin of the glabellar tongue (Pl. 16, figs. 4, 6). Margin of palpebral lobe with narrow rim, branches of suture distinct. Curving outward and backward from occipital furrow is a faint change in slope, the posterior border furrow (Pl. 16, fig. 2). Subparallel to this furrow and running out from the posterior margin of the occipital ring is a faint furrow that marks the boundary between the cranidial and protopygidial portions (Pl. 16, fig. 7). Short slim anterior cephalic spine, and the fixigenal spine of similar size; the latter situated close to the cranidial margin and at about half the width of the posterior border. Protopygidium strongly convex (sag. and tr.), especially posteriorly. At the curled posterolateral margin may be seen four pairs of tiny spines, a fifth, outer and larger anterior pair situated slightly farther inside the margin (Pl. 16, fig. 6); these five pairs about equi-distant from each other. Segmentation of the protopygidium is revealed by the transverse bands alternately finely granulate and smooth (Pl. 16, figs. 7, 9). These bands run subparallel to the faint furrow which separates cranidium and protopygidium and curve downwards and backwards over the steep sides. At least five bands can be distinguished following the occipital ring, but separate bands cannot be made out on the vertical lateral portion. Axis extremely faintly outlined in the first two of these bands following the occipital ring. The doublure is relatively broad and curled under, extending laterally as far as the posterior edge of the cranidial portion.

Degree 0. Both the cranidium (Pl. 16, figs. 8, 10-12) and transitory pygidium (Pl. 16, figs. 13-17) are relatively abundant at localities 3 and 4 and are like those of *R. asperulus* (Pl. 13, figs. 5-7, 11-15), notably in the distinctive form of the transitory pygidium. Occipital ring of cranidium convex, with median tubercle, occipital furrow deep, continued across fixed cheek by deep posterior border furrow. Glabella convex (sag. and tr.), tongue bent down vertically, anterior cephalic spine at anterolateral corner long and slim. Two pairs of lateral glabellar furrows visible (Pl. 16, fig. 10) in posteromedian part of glabella as smooth ovate areas; the anterior furrow directed diagonally inward, the posterior directed diagonally inward and forward. In anteromedian part of glabella is a narrow, sagittal, smooth band which dies out at base of tongue. Pair of tubercles close to mid-line of tongue (Pl. 16, fig. 8). No fixigenal spine on posterior border. Transitory pygidium with large articulating half ring. Along posterior margin 5 pairs of short spines arranged in a curving line (Pl. 16, fig. 17). Segmentation in the transitory pygidium again indicated by alternate granulate and smooth bands which curve downward and backward over the steeply sloping lateral portions. Six granulate bands may be recognized (Pl. 16, fig. 13), separated by five smoother bands, and on the vertical slope behind the sixth band may be seen (Pl. 16, fig. 16) a long narrow convexity representing the posterior part of the axis.

Developmental stages intermediate between those of this degree 0 and the supposed holaspis are not known. The degree 0 cranidium (Pl. 16, figs. 8, 10-12) is quite different in outline and convexity from that (Pl. 11, figs. 9-11) here placed in *R. caphyroides?*

REMOPLEURIDES SIMULUS n.sp.

Plate 17; Plate 19, figures 11, 12.

Holotype. USNM 137687 (Pl. 17, figs. 1, 2, 4, 5), locality 3.

Other Material. Paratypes USNM 137688a-c; all figured material in U. S. National Museum.

Geological Horizon and Locality. Lower part of Edinburg limestone, locality 3.

Description. This species, the fourth to be described from locality 3, does not resemble closely either *Remopleurides caelatus* or *R. caphyroides*, but differs from *R. eximius* in the following minor characters (these characters also serve to distinguish this species from *R. asperulus*, which occurs at a lower horizon):

Glabella with relatively slightly wider tongue (compare Pl. 17, fig. 1, with Pl. 15, fig. 1); the glabella and tongue are gently convex (sag. and tr.), the longitudinal convexity less than that in *R. eximius* (compare Pl. 17, fig. 2 with Pl. 14 fig. 3). Outline of palpebral rim gently curved, only slightly curved in posterior half, free cheek with slim librigenal spine situated in advance of the genal angle, the base being about opposite the posterior part of the eye lobe. Hypostome (compare Pl. 17, fig. 18 with Pl. 15, fig. 2) with strong curve to anterior margin, posterolateral corner angulate but not drawn out into a spine. Thorax (compare Pl. 17, fig. 11 with Pl. 15, fig. 7) distinguished by the flattened appearance of the axial rings, the tuberculation on the posterolateral margin being fine; pleurae likewise flattened, bladelike, the posterolateral corner extended into a blunt, backwardly-directed spine. The fifth thoracic segment from the posterior (probably the seventh segment) does not have elongated pleurae but the succeeding segment (probably the eighth) has a slim median axial spine. Pygidium (compare Pl. 17, figs. 11, 19 with Pl. 15, figs. 9, 13) with less inflated axis and consequent shallower furrows. Articulating process outside axial furrow prominent. Two pairs of pleural spines on posterior margin equally spaced from each other and without a markedly deeper median notch between the inner pair.

It may be argued that the exoskeletons included here under *R. simulus* may be sexual dimorphs of those exoskeletons included under *R. eximius*. An admittedly inconclusive argument against this view is that *R. simulus* does not occur at locality 4, where *R. eximius* is present. While localities 3 and 4 are not far apart geographically there may be a slight difference in horizon between them, as exemplified by the species peculiar to each locality (see lists above).

No early developmental stages of this species are known.

Remopleurides rugicostatus Raymond (1925, p. 57, pl. 3, fig. 3; this paper, Pl. 18, figs. 23, 24, 26, 27), from the Ridley limestone

(Wilderness stage) of Tennessee, is based on a single, incomplete, enrolled exoskeleton that probably has the outer exoskeletal layers missing. The cranidium and anterior thoracic segments are like those of *R. simulus*, and on the anterior pleural band of both species raised lines run in convex curves forward and outward from the pleural furrow. The pleura of the seventh segment does not appear to be elongated in *R. rugicostatus;* the axial ring of the eighth segment is broken. Free cheek, hypostome and pygidium are unknown in *R. rugicostatus*, and because of this lack of knowledge a new name is given to the Virginia material; clearly *R. rugicostatus* and *R. simulus* are closely related, the former being slightly the younger (Cooper, 1956, Chart I).

Genus ROBERGIA Wiman, 1905

ROBERGIA MAJOR Raymond, 1920

Plate 18, figures 1-22, 25.

Material, Localities and Geological Horizon. Lower part of Edinburg limestone (Liberty Hall facies), locality 14, a few cranidia and hypostomes from locality 16.

Description. This species was illustrated by Raymond (1925, pp. 60-61, pl. 3, figs. 6-10) and later redescribed by Cooper (1953, pp. 22-23, pl. 8, figs. 7-11). At the same time Cooper (1953, p. 22, pl. 12, figs. 10-14) redescribed the species *Robergia athenia* Butts, 1926, and some of the material he illustrated came from the present locality 14. Cooper stated (1953, p. 22) that *R. athenia* "differs from *R. major* chiefly in the shorter, more expanded frontal lobe of the glabella, by possessing a broad untapered axial lobe on the thorax, and by having the middle pair rather than the outer pair of pygidial spines longer than the other two." I consider the first two of these distinctions of doubtful value, and a re-examination of the type material of *R. major* shows that the pygidium bears three pairs of pleural spines, the outer pair extremely small and short, the middle pair the longest, the inner pair short and close together near the midline. The pygidium of *R. athenia* appears to be extremely similar and I therefore regard these two species as one, and they come from approximately the same horizon.

In redescribing the type species of *Robergia* (Whittington, 1950b, pp. 543-544, pl. 71, figs. 1-8), I pointed out that the hypostome was not known from the Swedish specimens. Raymond described the hypostome of *R. major* as bifurcated. The original material includes one specimen marked by Raymond as being the hypostome, but this specimen is a poorly preserved external mould of a pygidium. At locality 14 *R. major* is the most abundant of two remopleuridids that are present, and the hypostome described below is thought to belong to it.

Cranidium typical of *Robergia*, the glabella having 3 pairs of lateral glabellar furrows, the middle pair the longest and the most strongly curved. The basal glabellar lobe (Pl. 18, figs. 3, 5), situated adjacent to the inner end of the eye lobe, is subcircular in outline and has a faint independent convexity. Palpebral rim continuous with narrow anterior area of fixed cheek and preglabellar area (Pl. 18, figs. 3, 4, 7). Free cheek (Pl. 18, fig. 2) subtriangular in outline, a narrow convex border, the base of the genal spine situated opposite the midpoint of the eye lobe, the spine long and slim. Eye surface (Pl. 18, fig. 18) with many tiny facets arranged in diagonal lines. Doublure narrow, crossed anteriorly by a median suture. Hypostome (Pl. 18, figs. 8-14) subsquare in outline, anterior border flattened and continuous laterally with the large anterior wing. Lateral and posterior borders narrow, convex, separated from the middle body by deep furrow, small shoulder, spine at posterolateral angle. Middle body bearing the characteristic pair of gently convex ovate areas; anteriorly these areas separated by a triangular depressed area, this depression interrupted by the median boss; posteriorly the oval areas separated only by a shallow furrow. Doublure narrow, small posterior wing.

Pygidium (Pl. 18, figs. 15, 19, 22, 25) subrectangular in outline, slightly wider than long. Axis at anterior margin one-third of width, tapering evenly back to reach about four-fifths of the length and continued to the posterior margin by a narrow postaxial ridge. Some five axial rings may be distinguished. Pleural regions horizontal, the outer pair of pleural spines situated on the lateral margin at about three-quarters the length, the middle and largest pair at the posterolateral corner, and the third pair close together near the midline. First two interpleural ridges curve back to reach the posterior margin of the corresponding spine; third pair of interpleural ribs faint and close to the post-axial ridge. Doublure broad, inner margin reaching a line joining the anterolateral corner to the posterior tip of the axis.

The specimens are not well preserved, being somewhat flattened and distorted. Details of the external surface cannot be discerned except for the fine subparallel lines on the oval areas of the hypostome.

Development. Small specimens of only the cranidium are known, the smallest being of length (sag.) 1.2 mm. (Pl. 18, fig. 16). Glabella clavate in outline, the occipital ring narrow (sag.), convex, defined by a deep occipital furrow; the shallow axial furrows diverge forward to the maximum width opposite the anterior end of the eye lobes; in front of this point the glabella narrows slightly and is rounded. Three pairs of lateral glabellar furrows appear as short broad depressions, their positions being about as in larger cranidia, the posterior pair reaching the axial furrow, the anterior pair commencing inside the axial furrow and the shortest. Palpebral rim broad, convex, defined by a shallow furrow which runs anteriorly into the axial furrow. Anterior branches of the facial suture diverge forwards, then opposite the anterior end of the glabella curve around and run strongly inwards to meet the midpoint. A semicircular horizontal portion of the fixed cheek is thus enclosed between the palpebral rim and the axial furrow, and a further section of the fixed cheek and preglabellar area is enclosed between the anterior branches of the suture.

The next largest cranidium (Pl. 18, figs. 17, 20, 21) is of length (sag.) 1.88 mm. The glabella is now relatively broader and expands between the eye lobes so that only a narrow crescentic depression separates the glabella from the palpebral rim. In position and length the lateral glabellar furrows are much as in the largest cranidia and the basal lateral lobes display the subcircular outline and gentle convexity. The anterior part of the glabella, however, does not expand in front of the eye lobes but narrows slightly so that outside the axial furrows there is still a relatively broad portion of the fixed cheek. The preglabellar area appears relatively shorter (sag. and exs.). The free cheek that fits this size of cranidium is similar in form to that of the largest specimens known. The next largest cranidium known (Pl. 18, fig. 4) is approximately 4 mm. in length (sag.). Evidently during development to this size the glabella expands between the eye lobes so that the lateral margin is adjacent to the palpebral rim, and also expands in front of the eye lobes so that the anterior area of the fixed cheek becomes narrower.

The small pygidium (Pl. 18, figs. 15, 19), of length 1.5 mm., (sag.) is from locality 16 and is not distorted. It shows clearly the form of the pleural spines, in particular of the outermost pair.

Discussion of Development. Small cranidia of *R. major* (Pl. 18, figs. 16, 17, 20, 21) are like those of *Menoparia* (Ross, 1951, pl. 81, fig. 14; 1953, pl. 62, fig. 3) in width (tr.) of the anterior area of the fixed cheek and shape of the preglabellar area. *Robergia* may therefore be more closely related to *Menoparia* than to *Remopleurides.* In the development of the cranidium of *Robergia* the same major features are shown as in the development of *Remopleurides* — the expansion of the glabella between the palpebral rims and the reduction in width of the anterior area of the fixed cheek and the preglabellar area.

Robergiella n. gen.

Type species. Robergiella sagittalis n. gen., n. sp.

Discussion. The material included here occurs with *Robergia major* at locality 14, and with *Remopleurides caelatus* at locality 16, and displays holaspid characters that are intermediate between them. The cranidium has rather the form and outline of *Remopleurides,* the eye lobe being relatively long and the palpebral rim broad; the glabellar tongue expands forward, but apparently not as strongly as in typical *Robergia.* The three pairs of lateral glabellar furrows, however, are like those of *Robergia,* yet the basal glabellar lobe is not subcircular and slightly inflated. The free cheek is relatively broad with a narrow border and doublure, base of the genal spine being opposite the occipital ring. The thoracic segments lack the large axial articulating processes and sockets typical of *Remopleurides* and have the inner part of the pleurae crossed by a broad shallow pleural furrow as in typical *Robergia.* Axis of the pygidium includes only two pleural rings, the second divided by a median longitudinal furrow as in *Remopleurides,* and there is a post-axial ridge. Pleural regions are flattened, bordered by two pairs of long, tapering spines directed backwards, a strong interpleural ridge separating the proximal parts of the pleurae.

ROBERGIELLA SAGITTALIS n. gen., n. sp.

Plate 6, figures 16-33.

Holotype. USNM 137679 (Pl. 6, figs. 16, 17), locality 14.

Other Material. Paratype USNM 137680, all figured material in U. S. National Museum.

Geological Horizon and Localities. Lower part of the Edinburg limestone, Liberty Hall facies, localities 14, 14a and 16.

Description. Occipital ring longest in the midline, tapering distally to a blunt point at the axial furrow, the distal portion lying immediately behind the posterior part of the eye lobe. Median tubercle lies at the anterior margin. In front of the deep, narrow, occipital furrow, width of the glabella (Pl. 6, figs. 16-18) about the same as that of the base of the tongue; immediately in front of this basal portion the glabella expands between the palpebral rims. The tongue of length (sag.) less than half that of the eye lobe and curved only gently downward; narrow anterior area of fixed cheek. Three pairs of narrow, deep, lateral glabellar furrows, equally spaced from each other and from the occipital furrow, the anterior pair opposite the anterior part of the eye lobe; the furrows are diagonally directed, the first and second the longest, slightly curved, the third short.

Eye lobe moderately curved, convex palpebral rim defined by deep palpebral furrow; eye surface vertical with many tiny facets (Pl. 6, fig. 33), narrow convex external rim. Anterior branch of facial suture (Pl. 6, fig. 26) has a forward and outwardly directed course immediately in front of eye lobe; posterior branch of the suture (Pl. 6, fig. 16) directed strongly outwards across the posterior border so that it reaches margin at a point about two-thirds of the width of the cheek (tr.). Free cheek (Pl. 6, figs. 16, 17, 27) subtriangular in outline, greatest width along the line of the posterior border furrow, which is directed transversely. Anterolateral and lateral border narrow, convex, defined by a deep border furrow; at the genal angle the lateral border is continuous with the long slim genal spine. Posterior border slightly wider (exs.), small notch in the margin immediately inside the base of the librigenal spine. Doublure (Pl. 6, fig. 23) rolled beneath the border and not extending in beyond the lateral and posterior border furrows.

Three incomplete thoracic segments are known, one of which is attached to the holotype (Pl. 6, figs. 16, 17, 19, 24). Axial ring convex, inner part of pleura horizontal, transversely directed, and crossed by a deep diagonal pleural furrow; adjacent to the axial furrow the pleural furrow is subdivided by a low swelling, subtriangular in shape, which extends a short distance distally. Outer part of pleura curved, flattened, and pointed, the pleural furrow extending onto this portion and becoming shallower distally. One segment with long median axial spine.

Pygidium (Pl. 6, figs. 29-32) with convex axis tapering rapidly backwards, extending to about two-thirds the length (sag.), postaxial ridge becoming narrower posteriorly but reaching the margin. Axis with deep articulating furrow and subdivided into two rings by the shallow axial furrow; posterior of the two rings subdivided into two subcircular lobes by a median longitudinal furrow. Pleural regions horizontal, divided by an interpleural ridge which runs backward and slightly outward from the ring furrow, and by the postaxial ridge. Shallow pleural furrow curves outward and backward on the anterior segment, and adjacent to the axial furrow is subdivided by the low swelling. Each pleura continued by a backwardly directed gently tapering spine. Doublure broad, extending inward to tip of axis.

External surface bearing fine, raised, anastomosing lines, these lines running transversely on the occipital and axial rings, in curves convex forward on the outer parts of the pleurae of thorax and pygidium. On the free cheek between the eye lobe and the border furrows the raised lines form a reticulate pattern (Pl. 6, fig. 27). A row of small tubercles along the posterior margin of the occipital and axial rings. On the median axial spine of the thorax and the doublure, raised lines run longitudinally, subparallel to the margins.

Discussion. This species is not common at any of the localities at which it occurs, and the hypostome is not certainly known. A few small cranidia occur at locality 19 (Pl. 6, figs. 20-22) which may belong to this species. The example figured, of length (sag.) 2.13 mm., shows the three pairs of glabellar furrows (the anterior pair faint), and the palpebral rim is relatively wider than in larger individuals. This specimen is referred to below in connection with the indeterminable small remopleuridid.

REMOPLEURIDID gen. et sp. ind.

Plate 19, figures 1-10.

Material. Figured specimens, USNM 137689a-f.

Geological Horizon and Localities. Lower Edinburg limestone, localities 3 and 4.

Description. This cephalon occurs with *Remopleurides caelatus*, *R. caphyroides*, *R. eximius*, and *R. simulus*, and the largest cranidium known (Pl. 19, fig. 9) is only of length (sag.) 1.84 mm. It most closely resembles that of *R. caelatus* but differs from those of comparable size of this species (and of the other species mentioned). From *R. caelatus* (Pl. 3, fig. 16; Pl. 4, fig. 14) it is distinguished by the wider (especially posterolaterally) palpebral rim and the wider (tr.), more rapidly expanding and less steeply sloping glabellar tongue. The anterior area of the fixed cheek and preglabellar area are wider, and the outline of the anterior margin is bluntly pointed rather than rounded. The free cheek (Pl. 19, figs. 6, 10) may be distinguished most readily by the subangulate outline of the anterolateral margin, and by the sharp edge along this margin, formed by the acutely angulate junction between the sloping dorsal surface of the free cheek and the doublure. The posterior margin of the free cheek has a less prominent projection and makes a larger angle with the inner margin of the librigenal spine. The characteristic pit is present in the outer surface of the anterior part of the doublure. Successively smaller cranidia [sagittal length respectively 1.26 mm. (Pl. 19, fig. 8), 1.03 mm., (Pl. 19, figs. 5, 7)] differ principally from that described in the presence of the crescentic area of fixed cheek between the axial furrow and the palpebral furrow. Free cheeks associated with these cranidia are similar to those of larger size, and show the pit in the doublure. The smallest cranidium placed here (Pl. 19, figs. 1, 2), probably that of degree 0, is of length (sag.) 0.85 mm. It differs from cranidia of degree 0 of *R. caelatus* (Pl. 3, fig. 9) in that the anterior cephalic spines are longer and slimmer, not curved, and in that short, bluntly pointed fixigenal spines are present. A few examples of cranidia of the same size (Pl. 19, figs. 3, 4), lack the anterior cephalic spine, have the anterolateral margin smoothly curved, but are otherwise indistinguishable. Evidently the anterior cephalic spine is lost abruptly between moults.

Hypostome, thoracic segments and pygidium unknown.

Discussion. Inspection of the figures will show that the original of Plate 6, figures 20-22, of length (sag.) 2.13 mm., the smallest cranidium referred to *Robergiella sagittalis* n. gen., n. sp., might be considered to be a larger growth stage of the original of Plate 19, figure 9. The latter is the largest cranidium, length (sag.) 1.84 mm., placed in "remopleuridid gen. et sp. ind." Thus the series placed here might be the early developmental stages of *Robergiella sagittalis.* However, these two groups of specimens do not occur together at any one locality, though both come from the lower part of the Edinburg formation. Without more complete developmental series of both groups a decision as to whether or not they belong to two separate species cannot be made. Should they prove to be a single species, then the early development of the cephalon (remopleuridid gen. et sp. ind.) is more like that of *Remopleurides* than that of *Robergia* (Pl. 18, figs. 16, 17, 20, 21).

Distribution and Relationships of Remopleuridid Species from Virginia

Remopleurides appears first in the silicified material in the Upper Lincolnshire limestone, where it is represented by a single species, *R. asperulus.* In the Lower Edinburg limestone a great variety of remopleuridid species appear suddenly. There seems little doubt but that *Remopleurides caelatus* (the most abundant), *R. caphyroides,* and *R. eximius* are distinct species.

As noted above, the specimens included under *R. simulus* may be sexual dimorphs of *R. eximius* or they may be a further distinct species from Lower Edinburg limestone. *R. eximius* is so like the species from the Upper Lincolnshire that it is presumed to be its descendant. The antecedents of the other species are not known. In addition, in the Lower Edinburg limestone, *Robergia major* and *Robergiella sagittalis* are present. The abundance of types of remopleuridids in the Lower Edinburg limestone may be ascribed partly to their having come from a considerable variety of localities, but at all these localities the trilobite fauna is richer and more varied than at higher levels in the Edinburg or in the formations immediately below or above.

In the Oranda limestone, remopleuridids are not known, but in the succeeding lower part of the Martinsburg limestone one species, *Remopleurides plaesiourus,* is quite abundant. This species is exceedingly similar to *R. caelatus* and is most probably descended from it.

Comparison of the Virginia Remopleuridid Species with Those of other Areas

The morphological characters displayed by the Virginia species are seen in slightly different combinations in species from northwestern Europe across into China (Lu, 1957, pl. 153, figs. 14, 15, 16). Raymond (1925, p. 57) referred some material from Virginia to a Canadian species, and also erected the species *R. rugicostatus* on material from the Wilderness stage (Cooper, 1956) of Tennessee. This species is extremely like the slightly older *R. simulus* n.sp. (see above).

The type species of *Remopleurides, R. colbii,* from the Middle Ordovician of Eire (Whittington, 1950b, pp. 540-543, pl. 70, figs. 1, 2, 4, 5), has a cephalon (including hypostome) quite like those of the present *R. caphyroides.* However, the thorax and pygidium of *R. colbii* recall those of *R. eximius* (Pl. 14) and *R. simulus* (Pl. 17). There is a remarkable similarity between one specimen that I referred doubtfully to *R. colbii* (Whittington 1950b, pl. 69, figs. 5, 6), and the holotype of *R. eximius.* A second species from the same horizon in Eire is *R. dorsospinifer* (Whittington, 1950b, pl. 69, figs. 7-10), a species that has much in common with *R. caelatus* (Pls. 1, 2) and *R. plaesiourus* (Pl. 5, figs. 1-15). In 1950 (p. 542) I held the view that *R. dorsospinifer* might belong to a genus separate from *Remopleurides.* I would now expand the limits of *Remopleurides* and include *R. dorsospinifer* within this genus. A third species from Eire, *R. longicostatus* (Whittington, 1950b, pl. 70, figs. 3, 6), has the long genal spines (Pl. 7, fig. 4) and the long bladelike pleurae (Pl. 9, figs. 1-5, 7, 8) characteristic of *R. caphyroides.*

From Middle Ordovician horizons in Scotland come *Remopleurides girvanensis* Reed, (1903, pp. 39-41, pl. 6, figs. 8-15) and

R. biaculeatus Tripp (1954, pp. 664-666, pl. 2, figs. 1-12). The former of these species is like *R. eximius* from Virginia. *R. biaculeatus* bears a strong resemblance to *R. caelatus,* and Tripp's description includes such details as the pit in the cephalic doublure and the median boss and oval areas of the hypostome. Thorslund (1940, pl. 7) illustrated remopleuridids from the Middle Ordovician of Sweden. The cephalon of *R. validus* Thorslund is like that of *R. caelatus,* whereas the pygidium of this species is more like that of *R. eximius;* the pygidium of *R.* cf. *latus* Olin is more like that of *R. caelatus.* The thorax of *R. nanus elongatus* (Öpik, 1926, pl. 2, fig. 17), from the Middle Ordovician of Estonia, is like that of *R. simulus,* the pygidium (Öpik, 1937, pl. 24, figs. 1, 2) of *R. caelatus* type. There is evidently a closely related group of species of *Remopleurides* in the areas mentioned.

Quite similar species of *Robergia* are known in Oklahoma and the Appalachians (Cooper, 1953, pp. 22-24), Scotland and Sweden (Whittington, 1950b, pp. 543-4), in Middle Ordovician rocks, but do not seem to be known in Asia (I regard the illustrations referred to by Kobayashi, 1951, p. 20, as being of *Remopleurides*).

Superfamily TRINUCLEOIDAE Hawle and Corda, 1847

Trinucleidae and Raphiophoridae exhibit characters in common in both developmental and holaspid stages. In holaspides the occipital ring is narrow and lacks the doublure: in front of it the glabella expands forward and has the frontal part the most strongly convex. There are three pairs of subcircular or suboval muscle areas; the basal area is in many genera strongly impressed in the external surface, these impressions defining a narrow "neck" or a swollen ring, the occiput, in front of the occipital furrow; median pair is situated well up on the slope of the glabella, anterior pair small. Deep anterior pit. Cheek convex, posterior border defined by furrow which deepens distally and may form a pit; librigenal spine long; eye lobe bearing a compound eye absent, eye tubercle in some trinucleids; suture not passing across eye lobe but marginal or submarginal, free cheeks narrow (tr.) on dorsal surface, continuous ventrally, no median or connective suture. Hypostome subtrapezoidal in outline, convex middle body, narrow border defined anterolaterally and continuous around lateral and posterior sides; small wings. Seemingly hypostome not joined to cephalic doublure along a suture, but probably held closely beneath glabella by muscles.

Five or six thoracic segments, articulating furrow with a deep appendiferal pit, the horizontal pleurae bent down only at the extreme outer part, the doublure merely a curled-under edge, the pleural furrow strong. Articulating half ring lacking on first segment, which is bevelled anterolaterally. Pygidium subtriangular in outline with a gently convex, tapering axis reaching back to the rim. The larger part of the pleural regions is horizontal, the outer part bent down to form a steeply sloping border, the margin of this border typically sinuous, with a median posterior notch; doublure formed of the curled-under edge. Some ten segmental divisions may be revealed in the axis by up to five ring furrows and appendifers; muscle areas (commonly an inner and outer pair) may indicate further segments posteriorly; one to five pleural furrows. Apparently when enrolled, border of pygidium lay against inner edge of cephalic doublure.

The protaspides, described here for the first time, are similar in outline, convexity, and breadth of the gently convex axis. Up to three pairs of border spines may be present; in the cephalic portion the suture runs around the outermost edge of the pleural regions and narrow preglabellar area, posteriorly crossing the doublure in a sharp curve. In larger protaspides the glabella has the clavate form, the axis of the protopygidium is bulbous and vaguely defined, the pleural regions slope vertically posteriorly and have the median notch. Earliest meraspid cranidia display the clavate glabella with flat, steeply sloping sides and a median longitudinal keel, the occipital ring ill-defined. Convex cheek without border spines, posterior border best defined distally, by the pit. Suture is marginal and laterally has a slightly inwardly concave course. Alae, which are not evident in the protaspis, are relatively large and gently convex in trinucleids, *Ampyx*, *Ampyxina*, and *Raymondella*, but not in *Lonchodomas*. Small transitory pygidia have a transverse outline, a bulbous, ill-defined axis that does not taper posteriorly, the pleural regions slightly bent down beside the posterior part of this axis, the outermost parts of the pleural regions bent down to form the border. Typically there is a median posterior notch in the outline.

Between the protaspis and degree 0, border spines are lost while at degree 0 the frontal glabellar spine of raphiophorids makes its appearance. In immediately succeeding degrees the trinucleid fringe develops rapidly. Thus some familial (e.g. the raphiophorid frontal glabellar spine) and generic (e.g. the glabellar carina of *Lonchodomas*) characters are evident at degrees 0 to 1, whereas other generic characters (e.g. the expansion of the frontal part of the glabella in *Tretaspis* and *Raymondella,* or the fringe of *Tretaspis*) develop in immediately succeeding degrees.

Family TRINUCLEIDAE Hawle and Corda, 1847

The common characters of holaspides of this family have recently been discussed (Whittington, 1959, p. O420). The present material, however, shows the development more completely and, by virtue of the excellent preservation, in greater detail than heretofore. The protaspides of *Cryptolithus* (Pl. 23, figs. 11-16) and *Tretaspis* (Pl. 26, figs. 2, 3, 5, 6, 8-13) show a considerable likeness in form. Only degree 0 specimens were previously known, and they have no marginal spines on cheek lobe or transitory pygidium. The presence of such spines in the protaspis is thus unexpected, and their loss at the end of the protaspid period abrupt. The development of the glabella is similar in each genus — in the protaspis it has only a slight anterior expansion, this expanson increasing and a strongly convex, sharply carinate, form appearing early in the meraspid period in *Cryptolithus* (Pl. 23, figs. 1, 2, 9), in the late protaspid period in *Tretaspis* (Pl. 26, figs. 10, 13). Only in holaspides does this carinate form give place to a convexity that is rounded in transverse profile, while the anterior expansion becomes fully developed. Alae are not discernible in the protaspis, are largest at degree 0 (Pl. 23, fig. 6; Pl. 27, fig. 1), and are progressively reduced so that little or no trace of them remains in the largest holaspides (Pl. 20, figs. 4, 6; Pl. 24, fig. 1).

The border of the cephalon is at first a rolled margin, traversed on the upper surface by the marginal suture and at the genal angle continuous with the genal spine. A concentric row or rows of pits first appear (in late degree 0 and degree 1; Pl. 23, figs. 5, 7; Pl. 27, figs. 13, 19) in a deep trough which is immediately adjacent to the cheek lobes and preglabellar area, and there is a corresponding trough in the lower lamella. The first complete concentric row or rows has almost the same number of pits as in the holaspis. The fringe widens rapidly as additional concentric rows are added, and not until three such rows are present is the girder apparent (Pl. 22, figs. 1, 2, 5, 6, 10, 12; Pl. 28, figs. 1-4). The complete number of concentric rows appears fairly early in the meraspid development, and in the later meraspid and early holaspid periods relatively few pits are added and the fringe assumes its characteristic holaspid form — for example (compare Pl. 22, figs. 1, 2, with Pl. 20, figs. 4, 6, 7; Pl. 28, figs. 1-8 with Pl. 24, figs. 1-5), the lower lamella becomes sharply flexed at the girder as the latter becomes deeper, cheek roll and brim appear in *Tretaspis,* and concentric ridges and radial ridges and sulci appear in the upper and lower lamellae. The abrupt appearance of a new, complete concentric row of pits in the early meraspid degrees is accompanied by a marked increase in dimensions. Thus the early meraspides of *Cryptolithus* show a series of size groups corresponding to those with one, two and three complete concentric rows. It is hoped that the abundant material of *Cryptolithus* will permit a more detailed study of this phenomenon.

Early transitory pygidia (Pl. 23, figs. 3, 8, 10; Pl. 27, figs. 14, 15, 17, 18, 21, 23) have a bulbous axis which is broad and rounded posteriorly, the posterolateral parts of the pleural regions are bent down steeply, and the shallow median posterior notch gives a bilobate outline. During the meraspid period (Pl. 23, figs. 17-19, 21, 23; Pl. 27, figs. 20, 22, 24, 25) the outline becomes triangular, the axis gradually assumes the tapering form, the rings are better defined, the pleural regions become horizontal, with the outer parts bent down in the characteristic vertical border; in posterior view the outer margin of this border is sinuous and has a median notch.

While these parallels can be drawn between the development of *Tretaspis* and *Cryptolithus,* it is nevertheless evident that from the protaspis onwards the two genera can readily be distinguished. In the early meraspid degrees, for example, *Tretaspis* already exhibits such features as the relatively wider and more convex frontal part of the glabella, the more prominent eye tubercles and eye ridges, and the wider lateral part of the fringe with more pits.

Subfamily CRYPTOLITHINAE Angelin, 1854

Genus CRYPTOLITHUS Green, 1832

CRYPTOLITHUS TESSELATUS Green, 1832

Plates 20-23

Cryptolithus tesselatus, Whittington, 1941a, pp. 29-30, pl. 5, figs. 2, 15, 17, 18; Whittington 1941b, pp. 509-511, pl. 75, figs. 1-26, 46.

Material. Martinsburg shale, localities 9-12; all figured material in U. S. National Museum.

Description. All the features mentioned in my previous descriptions may be seen in the present illustrations. The radial plates between the pits of E_1 and the concentric ridge between I_1 and I_2 are both generally present (Pl. 20, figs. 2, 3, 4), though one or other may be poorly developed and in occasional specimens neither is prominent (Pl. 20, fig. 6). On the external surface of the glabella (Pl. 20, fig. 6), the network of raised ridges is strongly developed in the median and anterior areas: it is absent from the lateral slopes (compare for example *Reedolithus quebecensis* Stäuble, 1953, figs. 4, 5). On the internal surface (Pl. 20, figs. 9, 11; Pl. 22, fig. 7) there are small appendifers present in the occipital furrow and adjacent to the posterolateral margin of the occiput. In addition three pairs of muscle areas may be observed on the externally smooth, sloping, lateral parts of the glabella (Pl. 20, fig. 6), each suboval in outline, the basal pair situated in the lateral portions of the occiput, the median area a short distance in front, subcircular in outline, the anterior area smaller, situated at about the midlength of the glabella. These muscle areas may be distinguished on a few specimens by their slightly different color (Pl. 20, figs. 9, 11), and are not depressed as are the corresponding areas in *R. quebecensis* (Stäuble, 1953, figs. 4, 5). The median glabellar tubercle (Pl. 20, fig. 10) is a low, raised mound in the center of the network on the external surface of the glabella. Pits like those seen in the corresponding tubercle in *Tretaspis* *seticornis* (Størmer, 1930, pp. 85-87, fig. 37) have not been seen. External surface of cheek lobe usually smooth (Pl. 20, fig. 4), but an occasional specimen has shallow pits irregularly and closely scattered (Pl. 20, fig. 6). On neither the external nor the internal surface of glabella or cheek lobes have the raised lines described by Ruedemann (1916, pl. 35, figs. 6, 7) been observed.

The pits in each lamella of the fringe are opposing, deep, their flat bases in contact (Pl. 20, fig. 8; Pl. 21, fig. 17); during moulting the marginal suture separated the flat bases of opposing pits. Well preserved specimens show a minute hole in the center of the flat base of the pit, and in specimens in which both lamellae of the fringe are present this tiny opening can be seen connecting opposing pits. This opening appears to be an original structure and not the result of abrasion. The pits in harpids seem to have the same structure (Evitt, 1951, p. 607).

Three small specimens of the hypostome have been recovered (Pl. 21, figs. 18, 19), one of them approximately in position in a cephalon (Pl. 21, fig. 16) which is smaller than that of a degree 3 example (Pl. 21, figs. 14, 15). The hypostome was not found during the previous investigation (Whittington, 1941b, p. 517) and it is rare in the present material. Outline subsquare, slightly narrower across anterior margin than across posterior. Anterior margin curved convexly forward, forming a continuous curve with the slightly inwardly-directed lateral margin, there being no projecting anterior wing; posterior margin curved convexly backward. Middle body moderately convex, steeply sloping laterally; no anterior border, lateral border becomes defined by a shallow furrow anterolaterally and widens backward, merging with the broad posterior border which is narrowest in the midline; posterior border furrow shallow medially, becoming broad and deeper distally. Edges of lateral and posterior borders bent upward vertically, no doublure. In the specimen in which it is in place, the size and forwardly converging lateral margins enable the hypostome to rest a short distance inside the glabellar cavity; this position may approximate the position in life. There is no suggestion that the hypostome fitted against the inner margin of the lower lamella of the fringe along a hypostomal suture; indeed, if the posterior border of the pygidium came into contact with the inner edge of the lower lamella during enrollment, such a fit is not possible (Whittington, 1941b, p. 517).

Articulating half ring not developed on the anterior thoracic segment (Pl. 20, fig. 5; Pl. 21, figs. 1-3), present on succeeding segments (Pl. 21, figs. 4-7); deep appendiferal pits and stout appendifers, articulating devices in the axial furrow; facet exceptionally large on the anterior segment where it fits beneath the posterior border of the cephalon (Pl. 20, figs. 5, 7; Pl. 21, fig. 8), smaller on succeeding segments (Pl. 21, fig. 7); a posterior excavation in the narrow doublure receives the facet during enrollment. The articulating furrow of the pygidium (Pl. 21, figs. 9-13) also bears deep appendiferal pits and stout appendifers; on the first ring furrow the appendifers are faint; on the third they are replaced by an elongate-oval muscle scar; the succeeding ten or so rings are indicated by two pairs of muscle areas—an inner, smaller pair and a larger, outer pair which appear as shallow elongate depressions on the external surface.

Development

Protaspis. The originals of Plate 23, figures 11-16, and a number of additional specimens from localities 10 and 12, are believed to be the protaspis of *Cryptolithus tesselatus.* The other species occurring at these localities have been listed above, and the protaspides of *Diacanthaspis cooperi* (Whittington, 1956, p. 214) and *Flexicalymene senaria* (Whittington, 1941b, p. 495) have been described. From our unpublished studies of the ontogenies of the remaining species, or of species closely related to them, W. R. Evitt and I conclude that, by elimination, this protaspis can only be that of *C. tesselatus.*

Exoskeleton strongly convex, laterally and posteriorly sloping vertically or even slightly overhanging the margin. Widest at about one-third the length, posterior portion tapering more than the anterior, anterior margin with a median concavity in the outline. Glabella clearly outlined by shallow axial, preglabellar and post-occipital furrows, expanding slightly forward, gently convex, most strongly so at about the midlength (which point is in front of widest part of protaspis and seems to be surmounted by the median tubercle, Pl. 23, fig. 13), rounded anteriorly, separated only by the preglabellar furrow from the anterior sutural margin. Anteromedian part of protopygidium convex, steep slope down to post-occipital furrow, anterolaterally a line of change of slope runs out and back from the posterolateral angle of the glabella (Pl. 23, fig. 12); posterolaterally this median convexity dies out. Steep posterolateral slopes of protopygidium continued by narrow, curled doublure (Pl. 23, fig. 16); this doublure extends forward a short distance and is then cut off by a suture which crosses it in a curve convex backward; suture continues forward to bound lateral and anterior margins of shield. Free cheeks and hypostome unknown. Close to the posterior margin of the protopygidium, in the midline, a pair of thornlike spines (Pl. 23, figs. 12-14), their bases close together; each spine is directed backward and slightly inward, one directed horizontally and the other upward so that distally they cross. On the ventrally-facing doublure immediately below the bases of these spines there is a pair of ventrally-directed small tubercles (Pl. 23, figs. 14, 16). Posterolateral margins scalloped in outline, with a median posterior concavity. External surface finely granulate. Tiny crystals of quartz are scattered over the surface of the specimens, and in some cases give the appearance of a row of border spines. Examination of several specimens, however, shows that the position in which they occur is not consistent and that they are truly scattered grains.

Degree 0. Next largest are enrolled exoskeletons, lacking the lower lamella of the fringe, which are of degree 0 (Pl. 23, figs. 6, 8-10; maximum width across cheek lobes, 0.98 mm., which is considerably greater than maximum width of protaspis, 0.51 mm. in original of Pl. 23, figs. 14, 16). Cranidium subsemicircular in outline, more than twice as wide (tr.) as long; convex anterolateral part of cheek lobe sloping steeply. Glabella much more strongly convex than in the protaspis, with a rounded longitudinal crest and flattened, steeply sloping sides; occipital ring narrow (sag. and exs.), curved convexly backward, occipital furrow shallow medially, distally running into a deep pit; relatively large median glabellar tubercle situated on the highest point slightly behind the midlength. Ala of length (exs.) slightly greater than half that of the glabella, gently convex, subtriangular in outline, situated between the shallow axial and alar furrows, not separated by a furrow from the posterior border and distal part of the occipital ring.

Relatively large lateral eye tubercle, combined with a broad eye ridge, running inward and forward to axial furrow. Posterior border and posterior border furrow well defined, posterior border with characteristic backward curvature distally just inside where it is crossed by the suture. Marginal suture curves around genal angle and bounds narrow, outermost part of cheek lobe, which is gently sloping; in front of preglabellar furrow is a slight inward concavity in the course of the suture corresponding to that seen in the protaspis.

Pygidium with axis not tapering, posterior portion the most convex and bluntly rounded, axis merging, in slope which is concave upwards, with pleural regions, latter horizontal laterally. First axial ring outlined by ring furrow. Two pairs of pleural furrows extend a short distance out from axial furrows; narrow raised border to pleural regions, the outline of the steeply-sloping margin displaying a shallow median notch. External surface granulate, row of tiny granules around upper surface of pygidial border.

Larger meraspides. Cranidia having a width (tr.) between about 1.4 mm. and 3.0 mm. fall into three size groups, the successive groups having one (Pl. 23, figs. 1-5, 7), two (Pl. 22, figs. 10-12), or three (Pl. 22, figs. 1-4) concentric rows of pits respectively. These size groups do not necessarily correspond to degrees. There are individuals having one row of pits which belong to degree 1 (Pl. 23, figs. 1-4), but the smallest specimen described previously (Whittington, 1941b, p. 510, pl. 75, fig. 5) had one row of pits but belonged to degree 0. Similarly some specimens having three concentric rows belong to degree 3 (Pl. 21, figs. 14, 15) while others belong to degree 2 (Whittington, 1941b, pp. 510-11, pl. 75, fig. 4).

In the cephala with one row of pits the glabella has begun to assume the characteristic clavate form, is more strongly keeled, with flat steeply-sloping sides, and retains the large median glabellar tubercle. The ala is well developed, outlined distally by a curving alar furrow which has a steep slope on the outer side. Convex cheek lobe having the coarse reticulate raised lines on the external surface, the network coarsest on the inner part of the lobe. The gently sloping outermost part of the cheek lobes and frontal area of the cranidium is relatively wider, and the single row of pits is close to the inner edge.

Cephala show that the marginal band and lower lamella form a continuous rolled structure with this outer part of the cranidium, the suture running along the upper, outer margin of this roll. On the lower lamella the single row of pits lies at the bottom of the deep concentric groove, the inner part of the lamella being flexed to slope outward and downward; the margin curled; outline of this margin exhibiting a median projection which corresponds in shape with the notch in the posterior outline of the transitory pygidium (compare Pl. 23, fig. 7 with Pl. 23, fig. 3). At the genal angle the tubular structure of the fringe is continued by the genal spine, which is curved and directed backward.

The cephala with two rows of pits (Pl. 22, figs. 10-12) show little morphological change except that the ala is relatively smaller. The upper lamella of the fringe slopes outward and downward at a more gentle angle than the outer part of the cheek lobe, the marginal band is traversed by parallel raised lines, and the two rows of pits in the lower lamella are situated in a deep but broader groove. Inside innermost row of pits edge of lower lamella is tightly rolled to form a thickened, projecting edge.

In cephala with three rows of pits (Pl. 22, figs. 1-4), the median glabellar tubercle is relatively smaller and the median occipital spine has appeared for the first time as a large tubercle; the lateral eye tubercle and eye ridge are somewhat less prominent, and the ala is much reduced in size but proximally still merges into the distal part of the occipital ring and innermost part of the posterior border. The coarse reticulate pattern of the external surface is now clearly visible on the median part of the glabella, as well as the cheek lobe, and on the latter the reticulation extends down into the alar and axial furrows on each side of the ala; the reticulation is coarsest on the inner part of the cheek lobe, on the outer part it becomes finer, and there is a smooth band on the extreme outer slope. On the lower lamella (Pl. 22, fig. 2) the rows of pits are no longer at the base of a deep groove; the outer row E_1 is separated from the inner rows by the low but distinct girder, which at the genal angle runs out for a short distance along the under side of the genal spine. The inner edge of the lower lamella is tightly curled, the outline no longer having the slight median backward projection, but transverse or with a faint median notch. The single cephalon with the hypostome in position (Pl. 21, fig. 16) has three concentric rows of pits and belongs to this group in the size series.

Development of the transitory pygidium (Pl. 23, figs. 17-19, 21) is best shown by the isolated specimens. Four or five axial rings are defined by deep narrow axial furrows. Appendifers are present on the articulating furrow and on the first one or two ring furrows. Axis changes gradually in shape, becoming backwardly tapering and losing the strong convexity of the posterior part. At no time are distinct axial furrows developed. The inner part of the pleural region is horizontally extended, the outer part narrow and bent steeply down; at the flexure is the rim and a broad shallow groove inside this rim. Up to five pairs of deep, narrow, pleural furrows may be observed, in the smaller specimens the outline having a slight forward concavity. As size increases, these pleural furrows extend farther out, ultimately reaching the marginal furrow. Inter-pleural grooves are extremely faint, indicated only by a short depression situated just inside the marginal furrow, and best visible in the larger specimens. A row of small tubercles along the upper surface of the rim, and the steep outer parts traversed by raised lines. The slight median concavity seen in the posterior outline of the pleural regions in dorsal view is soon lost; at the same time the shallow median posterior notch in the margin of the steeply sloping outer parts becomes evident and increases in depth as size increases.

Larger meraspides and holaspides. Beyond the size group at which three concentric rows of pits first appear, changes that take place in the cephalon (Pl. 20, figs. 2-4, 6, 9, 11; Pl. 22, figs. 5-9) are relatively minor. The glabella gradually assumes the holaspid form, the occiput and muscle areas become visible, the median glabellar tubercle becomes relatively smaller while the median occipital spine lengthens. Both the ala, eye tubercle, and eye ridge gradually disappear. The raised network on the cheek lobe, which is coarsest and most prominent on the inner part, extends into the axial furrow, but as size increases it gradually disappears and in the largest specimens either the cheek lobe is smooth or it bears scattered shallow pits (Pl. 20, fig. 6).

Pits are added to the fringe only along the inner lateral and posterolateral areas. On the upper lamella the concentric ridge between I_1 and I_2 appears first, and later the raised radial ridges between the pits of E_1 become evident. On the outer surface of the lower lamella the girder becomes much stouter, especially anteriorly, projecting as a prominent ridge about which the lower lamella is flexed so that the inner part slopes upward and inward steeply. The ridges which separate I_1 from I_2, and I_2 from I_3, in the anterolateral and lateral part of the lower lamella also develop gradually. The inner edge of the lower lamella continues to be tightly rolled, but in ventral aspect the outline bears a decided shallow notch medially. This notch develops at the same time as the median posterior region of the pygidium begins to develop a slight projection (compare Pl. 22, fig. 5 with Pl. 23, fig. 20). During enrollment the steep outer parts of the pleural regions of the pygidium lie against the tightly curled inner edge of the lower lamella; study of the illustrations will show that the changes in outline of these two parts of the exoskeleton complement each other.

On small holaspid pygidia (Pl. 23, figs. 20, 22, 23) some eight axial rings are outlined by axial furrows which become shallower posteriorly; up to four pairs of narrow, deep, pleural furrows may also be observed. The largest pygidia (Pl. 21, figs. 10-13) are relatively longer than this small one, the pleural regions show the first and only a faint second pleural furrow, and the border retains the characteristic sinuous outline.

Measurements of the abundant specimens of the small developmental stages, and counts of the pits and their distribution, form a separate study which will be published elsewhere (cf. Whittington and Hunt, 1958, abstract).

Subfamily TRETASPIDINAE Whittington, 1941

Genus TRETASPIS M'Coy, 1849

TRETASPIS SAGENOSUS n. sp.

Plates 24-27; Plate 28, figures 1-8.

Tretaspis reticulatus, Whittington, 1941a (part), pl. 6, figs. 30, 34, 35.
Ampyxina elegans Cooper, 1953 (part), pl. 4, figs. 13, 17.
Holotype. USNM 137690 (Pl. 24, figs. 1-5), locality 16.

Other Material. Paratypes USNM 137691a-c; all figured material in U. S. National Museum.

Geological Horizon and Localities. Lower Edinburg limestone. Localities 2, 3, 4, 7, 14a and 16; road to Cherry Grove, 4 miles northwest of Linville, Rockingham Co., Va.

Description. Cephalon (Pl. 24, figs. 1-5) subsemicircular in outline, short genal prolongations and backwardly directed genal spine; length (sag.) and maximum height about half maximum width. Glabella expanding forward from the occipital ring to a width (at about one-third the length) almost twice as great, portion in front of occiput subhemispherical. Occipital ring narrow (sag.), backwardly curved, sloping gently forward to occipital furrow; latter shallow medially, distally deepening into a pit; occiput slightly narrower (tr.) than occipital ring, of about same length (sag.), gentle independent convexity; basal lateral glabellar furrow commencing a short distance inside the axial furrow, directed inward and forward, short and deep; second lateral glabellar furrow situated a slightly greater distance inside the axial furrow, and in the form of a deep subcircular pit; median glabellar lobe between lateral furrows strongly convex and merging anteriorly with the convex frontal lobe; third lateral glabellar furrow a small pit also situated a short distance inside the axial furrow and low on the steeply sloping flank of the frontal lobe; maximum width of glabella in front of third glabellar furrows.

Axial furrow shallow, broad posteriorly, a slight swelling adjacent to the extremity of the occipital ring probably represents the ala; shallow anterior pit. Inner part of cheek lobe gently convex, outer part sloping extremely steeply anterolaterally; posterior border furrow broad, deep, transversely directed, posterior border narrow, convex, flexed downward distally before it joins the internal rim of the fringe.

Fringe includes steeply sloping cheek roll and much less steeply sloping brim, entire fringe arched up medially; upper lamella with gently convex cheek roll and gently concave brim, narrow upper external rim; broad marginal band joins this rim to lower external rim, lower lamella subdivided by prominent girder which is deepest anteriorly where the cheek roll and brim lie at an acute angle to each other; posterolaterally the angle becomes oblique where the girder is less strong; along internal margin of lower lamella a narrow convex rim which is highest anteriorly and anterolaterally; between this rim and the girder the cheek roll is deeply concave anteriorly, but posterolaterally it becomes flat; brim between girder and lower external rim flat; external and internal rims meet at tip of prolongation and are continued by a long slim genal spine which is subtriangular in section, the three angles of the spine being continuous respectively with the external rim, the internal rim, and the girder. Marginal suture traverses upper edge of marginal band, at tip of prolongation curving to run along upper surface of internal rim, crossing this rim to reach the posterior margin of the cephalon about in line (exs.) with the distal part of the cheek lobe.

Fringe with two external rows of pits (E_1 and E_2); in the holotype each row has twenty-six pits on the right side, the twenty-sixth pit being a large one at the posterolateral extremity that is common to the two rows. Anteriorly and anterolaterally four rows of pits internal to the girder (I_1 to I_4), these pits being radially arranged with those of E_1 and E_2; the radial arrangement is undisturbed as far as R_{16} on each side, and narrow concentric ridges on the upper lamella separate the pits in each row, the ridge between I_3 and I_4 dying out at about R_{12} to R_{15}, the outer two ridges continuing to about R_{18} where they merge with a network of raised ridges surrounding the pits in the posterolateral region. In this latter region, beyond R_{16}, intercalation of pits makes the arrangement irregular so that the separate internal rows cannot be distinguished. On each side of the holotype at about R_{16} the row I_5 can be recognized because I_1 bifurcates. About nine pits along the posterior margin of the fringe. On the upper lamella the pits of E_2, E_1, and I_1, as far out as R_{16}, are in deep radial sulci; outside R_{16} only E_1 and E_2 are in radial sulci and a low concentric ridge separates E_1 from I_1. On the cheek roll of the lower lamella in the anterior and anterolateral regions the pits are in deep radial sulci.

External surface of glabella and cheek lobe (Pl. 24, fig. 7; Pl. 25, fig. 2; Pl. 26, fig. 1) bearing a network of strongly raised lines, network coarsest on the crest of the glabella and the inner part of the cheek lobe, becoming finer on the flanks of the glabella and not extending into the lateral glabellar furrows, absent from the axial and posterior border furrows, becoming finer distally on the cheek lobe and absent from the outer part. Small median glabellar tubercle situated at about half the length; behind this tubercle the raised lines form an almost straight median line that extends back to the occiput (Pl. 25, fig. 2). Eye tubercle situated opposite the median lateral glabellar furrow and far out on the cheek lobe on the edge of the steep anterolateral slope. Raised lines of the network forming a zig-zag ridge (the eye ridge) that runs inward and forward in the direction of the anterior lateral glabellar furrow.

Internal surface of glabella and cheek lobes (Pl. 24, fig. 2; Pl. 26, fig. 4) showing faint impression of network, deep pit at extremity of occipital furrow, and posterior and median lateral glabellar furrows form raised platforms; anterior glabellar furrow barely visible, anterior pit forming a small boss. No doublure on occipital ring or along posterior border. Fine subparallel raised lines traverse the girder and the ridge at the inner margin of the lower lamella (Pl. 25, fig. 4), and these fine lines continue along the angles of the genal spine.

In some specimens the muscle areas are distinguishable by their slightly darker color (Pl. 25, fig. 1). The seemingly smooth axial and posterior border furrows are in some specimens (Pl. 26, fig. 1) finely granulate, and similar fine granules run along the crests of the network of ridges (Pl. 25, fig. 2) as well as in the occipital furrow and along the posterior border. External surface of lateral eye tubercle apparently smooth; in the median tubercle of the glabella a suggestion (Pl. 25, fig. 2) of one or two tiny depressions, perhaps similar to those described in *Tretaspis seticornis* by Størmer (1930, p. 87, fig. 37). The structure of the pits in the fringe (Pl. 25, figs. 3, 4) is similar to that described in *Cryptolithus*, that is, the base of the pit is flat and may be pierced by a tiny median opening.

Three or four isolated thoracic segments (Pl. 24, figs. 6, 8, 9, 11, 12, 14, 15) have been recognized, both because of the similarity in form of the axial ring and articulating furrow to the occipital ring and furrow of the cephalon, and because of the small pygidium from locality 2 which is articulated with two segments (Pl. 24, figs. 10, 13). Axial ring narrow (sag. and exs.), moderately convex, articulating furrow deep and broad, descending distally into a deep appendiferal pit which projects ventrally as a triangular appendifer, slightly thickened at the tip. Articulating half ring short (sag.), that of the first thoracic segment narrower (tr.) than the axial ring. Pleura extends out horizontally, distally bent down in two stages, the first gently sloping, the outermost portion vertical, the margin curled under to form an extremely narrow doublure. Pleural furrow broad and deep, running out transversely to the extremity of the pleura, flanked by ridges the anterior of which is the wider (exs.); narrow posterior flange which extends out from the axial furrow to about two-thirds the width of the pleura. Anterolateral part of first thoracic pleura cut off diagonally and facetted so that it fits beneath the bent-down extremity of the posterior cephalic border; smaller facets on succeeding segments, a small depression in the posterior part of the doublure receives these facets during enrollment.

Pygidium (Pl. 24, figs. 16-19) about three times as wide as long, anterior margin transverse, posterolateral margins evenly rounded; axis gently convex, extending back so that tip merges into narrow rim, border bent down steeply. Five axial rings outlined by six ring furrows (counting the articulating furrow as the first) which are shallow medially and distally descend into a deep appendiferal pit, this pit situated a short distance inside the axial furrow. A seventh ring furrow is outlined by two pairs of subcircular darker areas, the inner pair being closer to the midline and smaller; on the external surface of some specimens these two pairs of dark spots are combined in one pair of elongate depressions. In one specimen (Pl. 25, figs. 5, 6) ring furrows 8 to 11 are indicated by darker muscle areas, the eighth by a median elongate dark area, the ninth by a similar median area and an outer pair of spots, the tenth and eleventh by two distinct pairs of dark spots. The dark areas indicating the ninth ring furrow are on the rim at the tip of the axis, those marking the tenth and eleventh on the upper part of the border.

Four pairs of pleural furrows are present, the first running outward and slightly backward, distally curving back and becoming shallower, not reaching the rim. The next three furrows are successively shallower, directed slightly more strongly backwardly, and display the slight distal curvature. In posterior view border of the pleural regions has a sinuous margin with a shallow median notch. On the inner surface (Pl. 24, fig. 16) appendifers are strongly developed on the articulating furrow, and are successively smaller on the three succeeding ring furrows. External surface of thorax and pygidium apparently smooth, except for the fine raised lines that run along the outer parts of the pleural regions.

Discussion. The above description is based on the largest specimens in the present material, which include cephala, thoracic segments and pygidia from locality 16, the largest cephalon being of maximum width about 1 cm. The originals of Cooper's (1953, pl. 4) figures 13 and 17, from locality 7, are like the original of Plate 24, figure 10, and unlike the pygidium here attributed to *Raymondella elegans* (Pl. 36, fig. 33), and so are attributed to *Tretaspis sagenosus* n. sp.

The description of the number and arrangement of the pits in the fringe is based on the holotype cephalon. Earlier (Whittington, 1941a, p. 29, pl. 6, figs. 30, 32, 34, 35) I referred material from similar horizons in Virginia to *Tretaspis reticulatus* Ruedemann, 1901. This latter species, from the Rysedorph conglomerate of New York State, has been redescribed by Stäuble (1953, pp. 210-211, figs. 21-24). The incomplete cephala on which *T. reticulatus* is based are of about the same size as the holotype cephalon of *T. sagenosus* (Pl. 24, figs. 1-5), and appear extremely similar. They may be distinguished, however, by the occurrence in *T. reticulatus* of I_5 as a complete row and I_6 laterally. The single incomplete cephalon from the lower "Athens" near Tenth Legion, Virginia (USNM 97436; Butts, 1941, p. 75, pl. 82, fig. 8; Whittington, 1941a, pl. 6, fig. 32), is of maximum width about 1.75 mm., and is exceedingly like *T. reticulatus* in having I_5 complete and I_6 present laterally. The silicified specimens described in 1941 (Whittington, 1941a, pl. 6, figs. 30, 34, 35), from the lower Edinburg limestone, four miles northwest of Linville Station, Va., display only I_4 as the innermost complete row, and in this respect are similar to many of the specimens in the present collection. Accordingly, these silicified specimens have been distinguished as a separate species, but the number of relatively large cephala with the fringe complete on at least one side is few, and inadequate to establish the amount of variation in the number and arrangement of the rows of pits. One or two examples will suffice to show that considerable variation does occur:—

a) Cranidium, maximum width 1 cm. (Pl. 24, fig. 7; Pl. 26, fig. 4), is like the holotype in having 25 or 26 pits in the complete rows on each side, I_5 commencing at about R_{16}. A single pit is intercalated between the two pits of E_1 and E_2, between R_{18} and R_{19}; and in addition, between R_{10} to R_{20} on each side, a third external row, E_3, is developed by subdivision of the pits in E_2. The presence of E_3 in the new species is a unique feature within the genus.

b) Incomplete cranidium, width of about 7 mm. (Pl. 26, fig. 1), displays some peculiarities, for in R_5 and R_7 there is no pit in E_2, only a pit in E_1; in R_8 and R_9 two pits are missing in I_4. However, in R_4 to R_7 (adjacent to the axial furrow) a few pits of I_5 appear.

c) Cephalon, maximum width 4.8 mm. (Pl. 26, figs. 14-16), from locality 2, has between 27 and 28 pits on each side in the external rows; E_3 is present between R_8 and R_{25} on the left side and between R_2 and R_{25} on the right side. This specimen displays by far the best development of E_3. I_5 commences at R_{16}, but is recognizable because I_1 divides into two rows beyond this radius, rather than because I_4 divides.

d) Fringe of left side (Pl. 26 fig. 7), from locality 2. This is much like the holotype and other specimens from locality 16 and has 26 pits on each side in E_1 and E_2. I_5 appears at R_{17}, again not because of the division of I_4 but because I_2 divides.

e) Part of cephalon displaying fringe on right side, from locality 14a (not figured) has 30 pits in E_1 and E_2, I_1 divides at R_{15}, and the row I_5 is complete. This latter feature at once recalls *T. reticulatus* and the present cephalon is of about the same size as Ruedemann's types.

f) Three incomplete cranidia from locality 7 have characters displayed by the holotype and two other specimens from locality 16.

This variation suggests that all the known material from Virginia (with the possible exception of the incomplete cephalon from near Tenth Legion) may be included in one species group, the central characters of which are displayed by the holotype here selected. In other specimens, and in by no means the largest known, I_5 is partially developed, rarely complete, and in some cases E_3 is incompletely represented. The development of I_5 suggests that *T. sagenosus* is related to *T. reticulatus* from New York, and one specimen from Virginia seems indistinguishable from *T. reticulatus.*

Tretaspis canadensis Stäuble (1953, pp. 202-210, figs. 17-20), from the Middle Ordovician Quebec City formation, differs from *T. sagenosus* in the more rectangular outline of the cephalon, the more swollen and longer (sag.) cheek roll, the steeply sloping brim, and the presence of a complete I_5 and an incomplete I_6. Stäuble (1953, p. 213) has distinguished his species from *T. kiaeri* Størmer, 1930, and it should be added that in *T. kiaeri* I_6 is only partially developed in relatively few specimens. This means that *T. kiaeri* approaches in many respects some of the specimens from Virginia.

Development

Protaspis. Smallest examples (Pl. 26, figs. 2, 3, 5, 6, 8, 9, 11, 12, 17) of maximum width about 0.4 mm., axis extending entire length, highest at one-third to one-half the length, sides flattened and steeply sloping, steep anterior slope, more gradual backward slope medially and an abrupt slope down in the most posterior part. Pleural regions gently convex, widest just behind the midpoint, tapering forward to give a rounded outline, posterior part narrowing more rapidly back, steep posterolateral and posterior slopes. Three pairs of long slim spines arise from the margins, one anterolateral, one at the greatest width, directed outward and slightly backward, a posterior pair situated close together and backwardly directed. A narrow doublure extends around the posterior half of the shield, reaching forward to a point beneath the bases of the lateral spines; lateral and anterior boundaries of anterior half of shield sutural, the suture curved inward very slightly along the lateral boundary. External surface granulate (what appear to be irregularly scattered short spines are small particles of quartz adhering to the specimens).

Larger protaspides (Pl. 26, figs. 10, 13) are similar in outline and retain the three pairs of border spines. Axis now divided by a faint ring furrow into a longer (sag.) cephalic portion which expands slightly forward, is rounded anteriorly, and much more strongly convex, with a marked keel, this keel extending back a short distance across the ring furrow; the protopygidial portion of the axis is convex, rounded posteriorly, and is slightly wider than the basal part of the glabella. Course of suture, and doublure, similar to that in smaller specimens.

Two protaspides occur in the material from locality 4 which seem by elimination to be those of either a raphiophorid or a trinucleid. That described above has been referred to *Tretaspis sagenosus* n.sp. because of its general similarity in form (apart from the anterolateral and lateral border spines) to that of *Cryptolithus tesselatus* (Pl. 23, figs. 11-16), and because the outline of the glabella, the strong backwardly projecting glabellar keel, and form of the protopygidial portion are like the smallest meraspides of *Tretaspis sagenosus* n.sp. (Pl. 27, figs. 1-3, 7, 14, 15).

Degree 0. One specimen of this degree (now unfortunately lost), had a cranidium alike in size and form to the original of Plate 27, figures 4-6, 10. Still smaller cranidia occur at localities 3 and 4 (Pl. 27, figs. 1-3, 7; maximum width 1.1 mm.). Outline of these is subpentagonal with an almost transverse anterior margin, anterolateral margin running inward and forward and making an acute angle with the posterior margin. Glabella expanding forward, strongly convex, carinate, steeply sloping flat sides, the carina projecting posteriorly behind the rest of the cranidium; median glabellar tubercle situated slightly in advance of the midlength. Axial furrow broad and shallow. Ala a vaguely defined gently convex area, subtriangular in outline, length (exs.) about half that of the glabella. Cheek lobe gently convex, deep pit in posterolateral angle which is continued inward a short distance by a faint furrow; proximally the posterior border is not defined. Sutural margin anterolaterally having a slight inward curvature.

Larger degree 0 cranidia (Pl. 27, figs. 4-6, 10) have a similarly shaped glabella except that the occipital ring is now defined by a shallow occipital furrow and projects slightly posteriorly. Axial furrow broad and shallow, deep anterior pit. Cheek lobes convex, these and the narrow preglabellar field having a gently sloping marginal flange which is the upper lamella of the fringe; this flange is broadest laterally and forms a triangular projection, situated a short distance in front of the projection made by the distal part of the posterior border. Latter now clearly defined by a border furrow. Ala relatively large, triangular, reaching forward to about half the length of the glabella, gently convex and lying below the level of the adjacent part of the cheek lobe. On the cheek lobe immediately in front of the ala is a low ridge directed outward and backward from the axial furrow; this is the eye ridge, but the eye tubercle is not yet defined.

The three smallest examples of isolated transitory pygidia (Pl. 27, figs. 14, 15, 17, 18, 21, 23), all seem by their size to belong to degree 0. Outline transverse, straight anterior margin, lateral margin straight and backwardly converging in the smallest specimens, changing with increasing size to an outwardly convex curve, posterior margin with a slight median notch. Axis convex, not tapering but broadly rounded posteriorly and merging into the pleural regions which are bent down behind the axis. The articulating half ring and two ring furrows are defined on the axis, and on the pleural regions the second and third pleural furrows become evident as short, faint depressions; pleural regions with narrow, sharply raised rim and narrow vertical border.

Degree 1. One complete enrolled exoskeleton (Pl. 27, figs. 8, 9, 11, 12), as well as isolated cephala (Pl. 27, figs. 13, 16, 19), cranidia and pygidia, are known. Glabella clavate, maximum height in advance of half the length, surmounted by median glabellar tubercle; occipital ring wider, curved to project back, occipital furrow shallow medially, deep distally. Ala now relatively narrower, convex and extending forward to a point about opposite half the length of the glabella. Broad eye ridge runs outward and slightly backward from the axial furrow to the highest point on the cheek lobe, where it expands slightly. Posterior border well defined, expanding distally and projecting back just where it joins the internal rim of the fringe. Fringe with broad external rim separated from the cheek lobes anteriorly and anterolaterally by a narrow trough; laterally this narrow trough widens to a triangular region between cheek lobe and external rim; external and internal rims merge into base of long, curving genal spine. In some specimens (Pl. 27, figs. 11, 12) pits are vaguely defined, in others (Pl. 27, figs. 13, 19) there is a double row of pits close together anteriorly and anterolaterally; laterally these two rows diverge to run along each edge of the depressed triangular region, and there are one or two additional pits scattered between them; 20 or 21 pits in the external row on each side. Lower lamella includes a broad external rim, a narrow depression in which the pits are situated, and an inner, rolled margin which is smoothly curved and has a slight median backward projection. Posteriorly the suture runs along internal rim, curves across the genal angle and runs forward along the upper, outer edge of the external rim.

The single thoracic segment is cut off diagonally where it fits beneath the bent-down outermost part of the posterior cephalic border. Transitory pygidium (Pl. 27, figs. 20, 22) now with lateral margins curving inward and backward, slight median notch in margin of border. Axis gently convex, not sharply defined by axial furrows; first and second axial rings narrow (sag.), convex, deep articulating and ring furrows. Three narrow and deep pleural furrows, the first extending out to the rim, the second and third successively shorter and more backwardly directed. Pleural regions not bent down so strongly behind the axis.

Larger meraspides and holaspides. Cephala of width slightly less than 3 mm. (Pl. 28, figs. 1-4), which must be of at least degree 3, are similar in form to those of degree 1. The glabella is slightly less convex longitudinally and does not bulge forward to overhang the fringe: cheek lobe and ala similar, the eye ridge broad and backwardly directed, the eye tubercle distinct and situated on the edge of the outer slope of the cheek lobe. Fringe is much broader, sloping gently outward and downward, the rims proportionally narrower, the pitted portion proportionally broader and not in a deep furrow. There are three complete rows of pits anteriorly and anterolaterally; laterally the inner and outer of these rows is continuous and between them are scattered and irregularly arranged pits. On the lower lamella the girder is present as a low ridge running inside the outermost row of pits and continuing onto the inner, lower angle of the genal spine. The reticulate pattern of raised ridges is present on the cheek lobe, and raised lines run along the external rim of the fringe and continue on to the genal spine. With the expansion of the fringe the prolongation also begins to develop, and the genal angle is now behind the posterior cephalic border.

Next largest cephalon (Pl. 28, figs. 5-8) of width 3.4 mm., frontal lobe of glabella relatively wider but glabella still sharply carinate, with the basal and median glabellar furrows now defined. Ala narrower and reduced in length, convex and posteriorly merging into the junction of the occipital ring and posterior border. Eye tubercle situated on edge of outer slope of cheek lobe and about opposite median glabellar furrow, eye ridge narrow adjacent to eye tubercle, becoming broader as it approaches and crosses the axial furrow. Reticulate pattern of raised lines now well developed on the median parts of glabella and cheek lobes. Fringe broader and sloping gently outward, five rows of pits anteriorly and anterolaterally, additional pits laterally; girder more prominent and separating the external two rows from the inner rows; 26 or 27 pits on each side in E_1 and E_2; on upper lamella low concentric ridge now separates I_1 from I_2. The cranidium of width about 6 mm. (Pl. 26, fig. 1) has assumed the essential characters of the largest specimens. The glabella now has the frontal lobe rounded in dorsal aspect and no longer carinate in anterior view, but gently rounded; the occiput and the basal and median glabellar furrows are well developed, the anterior glabellar furrow faint. Ala much reduced but visible as a distinct swelling in the broad axial furrow; eye ridge broad where it crosses this furrow. Fringe now with cheek roll more steeply sloping than the brim, the full complement of pits and the concentric ridges on the upper lamella separating I_1 to I_4.

Pygidia larger than those of degree 1 (Pl. 27, figs. 24, 25; Pl. 24, figs. 10, 13) show the axis becoming better defined, divided into at least five rings and tapering backward; pleural regions horizontal, three or four pairs of pleural furrows, and in transitory pygidia interpleural grooves may be observed (Pl. 27, fig. 24). The outer parts of the pleurae are bent steeply down and in posterior view the margin shows the shallow median notch.

Family RAPHIOPHORIDAE Angelin, 1854

Earlier diagnoses (Whittington, 1950b, p. 552; 1959, p. O426) now need emendation, in that the ala may, or may not, be united at the inner posterior corner to the extremity of the occipital ring, and the hypostome, the generalized characters of which are discussed below, is now known.

General Characters of *Ampyx, Lonchodomas, Ampyxina* and *Raymondella*

Holaspid Morphology

Cephalon (Pl. 29; Pl. 32, figs. 1-9, 12, 16, 17, 20; Pl. 34, figs. 3-17, 22; Pl. 36, figs. 1-7). The forwardly expanding glabella and variably developed frontal spine are characteristic. In all the species discussed here the occipital ring lacks a doublure. Occipital furrow variable in depth, distal part most pronounced. In *Ampyx* (Pl. 29, figs. 2-4) and *Lonchodomas* (Pl. 32, fig. 23) muscle areas are visible in the outer part of this furrow. The lateral glabellar furrows are not developed as narrow, deep troughs, but rather as subcircular or suboval areas which may be slightly depressed in the external surface. The exoskeleton is thinner over these areas and in many specimens appears of a different color, or because of its thinness may be broken through (Pl. 34, fig. 3). These areas have been referred to as muscle areas, since in the silicified material this is what they seem to be (cf. Whittington and Evitt, 1954, pp. 24-25). Three pairs of muscle areas in front of the occipital furrow have been observed in *Ampyx, Lonchodomas,* and *Ampyxina,* in *Raymondella* one pair. The pair common to all these genera is the basal or preoccipital, and is generally impressed into the outer surface and in, for example, *Ampyxina* (Pl. 34, figs. 3, 15) and *Raymondella* (Pl. 36, fig. 2) gives a pinched-in appearance to the basal part of the glabella. The second of these muscle areas is about half way up the steeply sloping side of the glabella in *Ampyx* (Pl. 29, figs. 2, 3) and *Lonchodomas* (Pl. 33, figs. 31, 32), the third close to the anterior pits in these genera, but in *Ampyxina lanceola* (Pl. 35, fig. 32) it is a short distance inside the axial furrow.

In *Ampyx* (Pl. 29, figs. 1-3) there is an elongate, narrow (tr.), gently convex portion of the glabella between the axial furrow and the outer edges of the first two muscle areas which extends forward to the third (anterior) muscle area. The corresponding region in the glabella of *Ampyx linleyensis* Whittard (1955, pp. 18-21, pl. 2, figs. 1-5) has been described by Whittard as the ala. It seems to me more likely, in view of the developmental series described here, that this region is part of the true glabella, i.e., it is within the axial furrow in *Ampyx linleyensis* as it is in *A. virginiensis*.

Cheek is convex, subtriangular in outline, with a well defined posterior border, the posterior border furrow running distally into a deep pit. Lateral and anterior borders are narrow, well defined in *Ampyx*, *Ampyxina*, and *Raymondella*. The anterior border furrow is weak or absent on the fixed and free cheeks adjacent to the suture line (Pl. 29, figs. 5, 6; Pl. 34, figs. 14, 17; Pl. 36, figs. 4, 5). In *Lonchodomas* anterior and lateral cephalic borders of comparable width are not outlined by border furrows (Pl. 32, figs. 1, 7). Facial sutures have a characteristic course, commencing on the posterior border a short distance in from the genal angle, curving outside the pit in the posterior border furrow, then running across the lateral part of the cheek in a curve concave outward, and meeting along the anterior and anterolateral margins of the cephalon. There is no trace of median or connective sutures, as some of the more complete specimens show (Pl. 29, figs. 5, 6; Pl. 32, figs. 2, 3; Pl. 34, figs. 7, 8; Pl. 36, figs. 1-4). The librigenal spine arises from the genal angle and the upper part of it merges into the upper surface of the cheek at the genal angle. Librigenal spines are at first outwardly and backwardly directed and may curve to point backward and extend for a lesser or greater distance beyond the pygidium. *Lonchodomas carinatus* (Pl. 32, figs. 4, 5; Text-fig. 8) is most unusual in the hooked form of the genal spine, but even so, if the restoration is correct, the tip of the spine extends just beyond the pygidium.

The hypostomes of *Ampyx* (Pl. 29, figs. 9, 10, 12-16), *Lonchodomas* (Pl. 32, figs. 6, 8, 9, 12, 17) and *Ampyxina* (Pl. 34, figs. 5, 9) have the following characters in common: greatest width across anterior wings, anterior margin either curved convexly forward or three sided, lateral borders convergent backward. Middle body convex, anterior border becoming defined along distal part of anterior margin and continuous with lateral and posterior borders. Macula situated on posterolateral part of middle body. Anterior edge rounded, thin, edges of lateral and posterior borders turned up to slope vertically and excavated between wings; no anterior wing process, posterior wings small.

The hypostome has not been found in position. The thin, rounded anterior edge, and the similar inner edge of the anterior part of the cephalic doublure, do not suggest that the hypostome was linked to the cephalic doublure along a hypostomal suture, for along such junctions the edges are usually thick and flat. Further, the curvature of the outline of the anterior margin of the hypostome does not correspond exactly with that of the inner margin of the cephalic doublure. An enrolled specimen of *Ampyx nasutus* (Whittington, 1950b, pl. 74, figs. 5, 6, 8) shows the border of the pygidium lying close against the inner edge of the cephalic doublure, implying that the hypostome could not have been joined to this edge. In *Lonchodomas* (compare Pl. 32, figs. 2, 3, with Pl. 32, figs. 18, 21) the outline of the inner margin of the anterior portion of the cephalic doublure, with its median notch, accurately corresponds in curvature to that of the border of the pygidium. The same may be said of *Ampyxina powelli* (compare Pl. 34, figs. 7, 8 with Pl. 34, figs. 3, 4) and *A. lanceola* (compare Pl. 34, figs. 15, 16 with Pl. 34, figs. 25, 27), and is probably also true of *Raymondella*. It is therefore suggested here that in raphiophorids the hypostome was held close beneath the glabella and that perhaps muscles held the anterior wing close beneath the prominent anterior boss (Text-fig. 8c); during enrollment the border of the pygidium lay against the inner edge of the cephalic doublure. These statements apply equally to *Cryptolithus tesselatus* (Pl. 21, fig. 16; Whittington, 1941b, p. 517, pl. 75, fig. 2).

Thorax of six segments in *Ampyx* (Pl. 30, figs. 1-5), five in *Ampyxina* (Pl. 34, figs. 3, 4), and probably five in *Lonchodomas* and *Raymondella* (Whittington, 1950b, p. 557-58); axis relatively narrow, pleurae and pleural regions horizontally extended, only the outermost parts bent down steeply or vertically, doublure narrow and tightly curled under (Pl. 30, figs. 6-13; Pl. 32, figs. 10-15; Pl. 34, figs. 18-20; Pl. 36, figs. 24-26, 29-32). The outer parts of the thoracic pleurae become longer (tr.) in successively posterior segments, the anterolateral edge of the first segment is cut off where it fits against the cephalon, facets on the succeeding segments fit into recesses in the doublure during enrollment. Pleural furrows well defined.

Pygidium (Pl. 30, figs. 14, 16, 17, 20; Pl. 32, figs. 18, 19, 21, 22; Pl. 34, figs. 25-27; Pl. 36, figs. 33, 34, 37) with axis tapering back to rim, eight or nine segmental divisions indicated by ring furrows or muscle areas in *Ampyx, Lonchodomas* (cf. Størmer, 1949, p. 178, fig. 146) and *Ampyxina*, four in *Raymondella*. Inner part of pleural region flat, variably furrowed, outer part forms a broad vertical border, the margin of this border characteristically sinuous in outline, with a median posterior notch.

External surface smooth or finely granulate, anastomosing raised lines on cheek of *Raymondella*, raised lines running subparallel to the margins on the cephalic, including hypostomal, borders and on the outer parts of the thoracic pleurae and pleural regions of the pygidium.

Development

Protaspis. A protaspis here attributed to *Ampyx* (Pl. 30, figs. 21-30) is the only one known among raphiophorids. Axis is broad, subparallel sided, most convex in the cephalic portion. Pleural regions slope steeply laterally and behind the axis. Free cheeks and hypostome not known, the cranidial portion being bounded by the facial suture, which has a scalloped outline, including a gentle curve concave outward along the anterolateral margin. In the smaller specimen the suture curves across the doublure at about half the length (Pl. 30, fig. 30); in a larger specimen (Pl. 30, fig. 22) the suture crosses the doublure much farther backward, at about four-fifths the length, in a curve that is sharply convex backward so that a tiny projection is isolated on the inner part of the doublure. Two pairs of marginal spines, one anterolateral, the other posterior; between the posterior pair the margin is deeply notched in posterior view (Pl. 30, fig. 27) and the doublure of this notch bears a tiny pair of downwardly and inwardly directed spines. In its general form, and in such details as the course of the suture across the doublure and the posterior notch with its ventrally directed spines, this protaspis is remarkably like that of *Cryptolithus* (Pl. 23, figs. 11-16). It is similar to, but less strikingly like, the protaspis of *Tretaspis* (Pl. 26, figs. 2, 3, 5, 6, 8-13, 17).

Meraspides. Early meraspid degrees are known of at least some species of all the genera here considered. The only example of a degree 0 exoskeleton is one questionably attributed to *Ampyx* (Pl. 31, figs. 1, 2). This latter suggests that the two pairs of border spines of the supposed protaspis are reduced, and lost abruptly, between the protaspis and onset of the meraspid degrees. At the same time, the frontal glabellar spine, which is not present in the protaspis, appears abruptly at degree 0. This phenomenon of the abrupt disappearance and/or appearance of spines between the protaspid and early meraspid degrees is paralleled in the development of quite unrelated trilobites — for example Remopleurididae, or Odontopleuridae (Whittington, 1956).

The earliest developmental stages of *Ampyx* (Pl. 31, figs. 3-5, 21, 22), *Ampyxina* (Pl. 35, figs. 1-3, 5, 6, 10, 11), *Lonchodomas* (Pl. 33, figs. 1-3, 4, 7), and *Raymondella* (Pl. 36, figs. 18, 19, 22, 23, 27, 28) show a family resemblance to one another — in the clavate, keeled form of the glabella with its frontal spine, outline of the cheeks and faintness of the posterior border furrow, development of the alae (except in *Lonchodomas*), and form of the transitory pygidium with its axis expanded posteriorly and the posterior part of the pleural regions bent down sharply, the pleural regions having a narrow raised rim. Nevertheless, generic characters such as the cranidial outline and carinate glabella of *Lonchodomas*, and the constriction in the pre-occipital part of the glabella of *Ampyxina* and *Raymondella*, are apparent at this stage. These latter two genera are alike at degree 2 (compare Pl. 35, figs. 5, 6, 10, 11 with Pl. 36, figs. 18, 19, 22, 23), the inflation of the anterior part of the glabella of *Raymondella* — a generic character — taking place after this stage. The development of the hooked shape of the librigenal spine of *Lonchodomas* takes place in the later meraspid degrees (Pl. 33, figs. 11, 16). Some developmental features are common to all — increase in convexity of the glabella, deepening of the posterior border furrow of the cephalon, flattening out of the pleural regions of the pygidium and development of the steep pygidial border. Other morphological features such as the keel of the glabella or the frontal glabellar spine may be progressively augmented (*Ampyx* and *Lonchodomas*), or reduced almost to disappearance (*Ampyxina, Raymondella*) in the largest individuals. Alae are barely discernible in the supposed late protaspis (Pl. 30, fig. 29) and degree 0 (Pl. 31, figs. 1, 2) of *Ampyx*, but are clearly visible at about degree 2 of *Ampyx* (Pl. 31, figs. 3, 7), *Ampyxina* (Pl. 35, fig. 5), and *Raymondella* (Pl. 36, fig. 16). At this stage they are triangular areas enclosed between the axial and alar furrows, gently convex, and posteriorly weakly separated from the border, the inner posterior corner merging into the extremity of the occipital ring. Alae are not present at any known stage of *Lonchodomas*. In the later development of the genera in which they are present, they may be progressively reduced and disappear in the holaspis (*Ampyx*), or be retained (*Ampyxina, Raymondella*). In *Raymondella* (Pl. 36, figs. 1, 2) the convex portion is separated from the posterior border and occipital ring by a depression, but in *Ampyxina* (Pl. 34, figs. 3, 15, 16) the inner posterior corner is connected to the extremity of the occipital ring. From the evidence reviewed here it seems reasonable to conclude that the alae are not part of the glabella, though they seem to be closely connected to the basal part of it. Alae are present in the development of species of the closely related family Trinucleidae, are similar in appearance to those of raphiophorids, and in some species appear to be retained in the holaspis (Whittard, 1955, pp. 32, 36). Størmer (1930, p. 65) concluded that the alae of Trinucleidae belonged to the glabella, but in view of what we now know of raphiophorid development this statement may be open to question. No light can be shed on the question of the function of the alae.

Genus AMPYX Dalman, 1827

AMPYX VIRGINIENSIS Cooper, 1953

Plate 29; Plate 30, figures 1-14,
16, 17, 20-30; Plate 31; Text-figure 7

Figured Material. All in USNM

Geological Horizon and Localities. Lower part of Edinburg limestone, localities 2, 3, 4, 5, 6, 16.

Description. Reconstruction of exoskeleton (Text-fig. 7) shows outline and convexity; length (sag.) of cephalon almost half that of exoskeleton. Glabella (Pl. 29, figs. 1-4) narrowest across occipital ring; this ring is sharply ridged, with a vertical posterior slope and a steep slope down to occipital furrow, and not separated by a depression at the axial furrow from the posterior border. Posterior, ventral edge of occipital ring thickened, but doublure absent. Occipital furrow broad and shallow, in dorsal aspect both occipital furrow and ring curved convexly backward. Glabella, defined by shallow axial and preglabellar furrows, expands forward to a maximum width at about one-third the length, anterior part rounded in dorsal outline, projecting beyond cephalic margin, and drawn out into long, curved spine, the tip of which is directed upward and slightly backward: glabellar spine round in section, longitudinal lateral furrow in proximal portion: behind base of spine glabella rounded (not carinate) along midline, sides flattened and steeply sloping. Four pairs

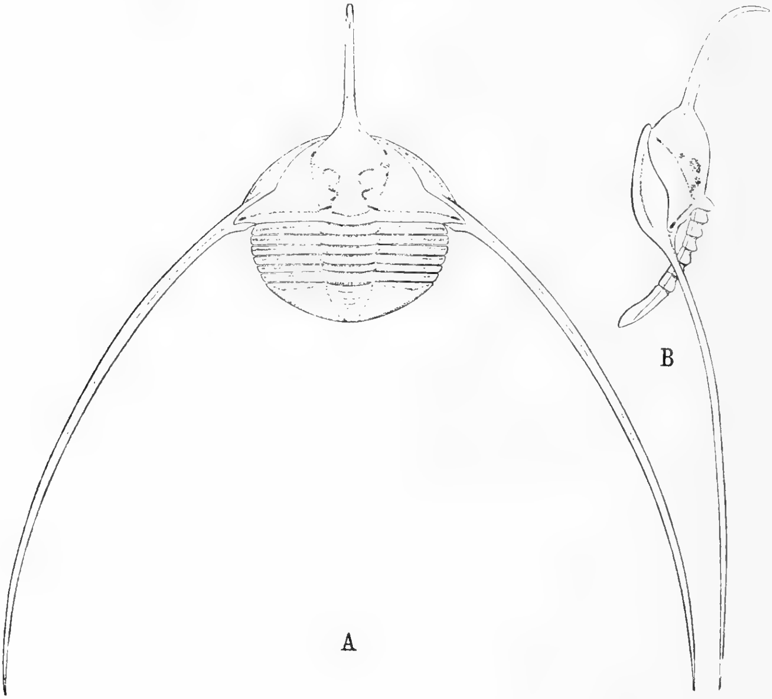

Figure 7. *Ampyx virginiensis* Cooper, 1953. Reconstruction, A, dorsal, B, left lateral views. Approximately X 2.

of muscle areas (visible by their colour, the thinness of the exoskeleton over them, or by being impressed): occipital area elongate-oval, situated in outer part of occipital furrow, adjacent to it is subcircular first lateral scar, the anterior, inner and posterior boundaries of which are impressed into glabella, and the outer, posterior corner connected by a shallow depression to the occipital area; second lateral area larger, subcircular in outline, situated immediately in front of first and half way up slope of glabella, not impressed; third lateral area smaller, subcircular in outline, adjacent to axial furrow and at greatest width of glabella. In axial furrow, adjacent to posterior border furrow, there is a narrow (tr.), short (exs.) depression, probably a muscle area; anterior pit deep, elongate, situated in front of third lateral muscle area.

Cheek (Pl. 29, figs. 5-8, 11) gently convex, lateral and anterior border narrow, flattened, defined by change in slope rather than a furrow; border flexed down at margin and rolled under to form a doublure which is no wider than the border; anterior border and preglabellar furrows coincident. Posterior border a sharp ridge, anteriorly sloping to broad shallow posterior border furrow, latter with deep pit distally; distal part of border bent down; on posterior edge, just inside suture, is a socket to receive anterolateral corner of first thoracic segment. Facial suture cuts posterior margin near extremity of border, from here runs outward and slightly forward, curves abruptly back over posterior border furrow outside distal pit, follows a gently sinuous course across outer part of cheek, and two branches meet in smooth curve along anterior margin of border. No median or connective sutures. Librigenal spine long and gently curved, base formed by extensions of lateral and posterior cephalic borders; posterior border furrow of cephalon is continuous with shallow longitudinal furrow on upper surface of librigenal spine, similar furrow on lower surface of spine so that, proximally, cross-section is hour-glass shaped; furrows die out distally; an elongate depression on inner side of spine near base. Anterolateral and anterior parts of cephalic doublure divided by a flexure into an outer, wider, flat part and an inner, gently convex part; flexure has a slightly sinuous course; inner edge of doublure thick, rounded, traversed by fine raised lines.

Hypostome (Pl. 29, figs. 9, 10, 12-16) shield-shaped, anterior margin gently curved convexly forward, medially no anterior border; distally a gently convex border becomes defined and is continuous with lateral and posterior borders; shallow border furrow. Middle body most convex in median part, gently sloping anterolaterally; thinner area in anterolateral corner adjacent to border, probably a muscle area; shallow pit in border furrow posterolaterally. In lateral and posterior views (Pl. 29, figs. 14, 15) border is seen to be deepest (i.e. extended dorsally but not curled inward) laterally and posteriorly, and outline shows a lateral and median posterior scallop, with a long, pointed posterolateral projection (the posterior wing) between the scallops.

Thorax (Pl. 30, figs. 1-13) of six segments, first the longest (sag. and exs.), succeeding segments progressively shorter, and, after the second, narrower (tr.); axis gently convex, one-third of total width and tapering slightly. Subcircular distal part of axial ring gently inflated, posterior edge of ring with slight median indentation; articulating furrow broad and shallow, running in curve concave forward, articulating half-ring and doublure of ring short (sag.); oval area in outer part of articulating furrow is slightly more depressed than rest of furrow and may be different in colour, and is probably a muscle attachment area. Small axial articulating processes and sockets, absent only between first thoracic segment and occipital ring. Inner part of pleura horizontal, outer part of pleura short (tr.), bent down steeply; pleural furrow broad, shallow, directed slightly diagonally, deepening and curving forward as it reaches fulcrum and ends against facet; in dorsal aspect line of fulcrum is inward and forward on first segment, on succeeding segments progressively more strongly inwardly and backwardly directed, giving characteristic outline to thorax; in addition outer part of pleura is longer (tr.) on succeeding segments (compare Pl. 30, fig. 6 with Pl. 30, fig. 8). Fulcral articulating process and socket on each segment, including process on first segment which fits into socket in posterior border of cephalon where latter is flexed downward. Doublure of pleura short (tr.), curled under outermost part of pleura; each pleura with small facet on outer part, the tip of the facet being received during enrollment by a depression in the doublure of the preceding segment, this mechanism providing a limit to amount of enrollment.

Pygidium (Pl. 30, figs. 14, 16, 17, 20) three times as wide as long, gently convex axis tapering back to reach inner margin of border. Articulating furrow with deeper outer part, short (sag.) articulating half-ring. Eight or nine axial rings indicated by furrows which are deepest medially and become progressively fainter posteriorly. In outer part of each furrow an oval muscle area, corresponding in position with deeper part of articulating furrows of pygidium and thorax. Inner part of pleural region horizontal, crossed by broad pleural furrow running in curve concave forward; area in front of this furrow bent to slope upward and forward, most strongly bent distally adjacent to articulating process and inner part of facet. Border slopes steeply and is broad, edge curled under and in posterior view with a characteristic bow-shaped outline imposed by the greatest width being posterolateral and by the median posterior notch.

External surface smooth (or extremely finely granulate) but not ''punctate'' as stated by Cooper (1953, p. 16), fine granulation on glabellar spine (Pl. 29, figs. 1, 3) and on proximal part of librigenal spine, fine raised lines on outer part of cephalic border, border of hypostome, and outer part of pleural regions of thorax and pygidium, these lines running subparallel to the margins.

Discussion. Ampyx virginiensis is extremely like the type species *A. nasutus* (Whittington, 1950b, pp. 554-556, pl. 74, figs. 3-9, text-fig. 6) from the Lower Ordovician of Sweden, differing only in such features as the less forwardly projecting glabella, narrower anterior and lateral cephalic border and relatively shorter pygidium.

Cooper (1953, pp. 16-17, pl. 7, figs. 1-11, 18) erected this species for material from the present localities 2 and 6. The relatively longer (sag.) pygidium, with deeper axial furrows, of *Ampyx americanus* (Cooper, 1953, pl. 5, figs. 3-5, 8, 9 [figure 3 is X2, not X5 as stated by Cooper]), from a similar horizon in Tennessee, serves to distinguish it from *A. virginiensis*. *A. camurus* (Cooper, 1953, p. 16, pl. 5, figs. 1, 2, 6, 7; this paper, Pl. 30, figs. 15, 18, 19), is distinguished from *A. virginiensis* by the more convex frontal portion of the glabella and the relatively longer pygidium which has a more triangular outline. Both species occur at about the same horizon in Virginia, but *A. camurus* has not been found among the silicified material. From the same locality and horizon that yielded *A. camurus* came also *A. lobatus* Cooper, 1953 (p. 16, pl. 6, figs. 3, 4), based on a distinctive pygidium that exhibits the second and third pleural furrows extending across the inner pleural regions. Comparable furrows are not present on pygidia of *A. virginiensis* of the same size. I have not seen the type material of *Ampyx? hastatus* Ruedemann (1901, pp. 48-54, pl. 3, figs. 1-10, 30), but it appears to differ from *A. virginiensis* in the presence of the carina on the glabella, the prismatic section of the frontal glabellar spine, and outline of the pygidium. *A. virginiensis* has one, rather than two, anterior glabellar muscle scars.

Whittard (1955, p. 19, pl. 2, fig. 8) has described the hypostome of *Ampyx linleyensis*. That of *A. virginiensis* is similar, but wider (tr.) across the anterior wings, the position of which is revealed by the muscle area. Whittard interprets the projection bounding the anterior margin of the notch in the lateral border as the anterior wing in *A. linleyensis*, but by analogy with *A. virginiensis* the anterior wing may be in advance of this position.

Development

Protaspis. The protaspis here attributed to *A. virginiensis* occurs at localities 3 and 4, where small developmental stages of the species are quite abundant. This protaspis does not seem to be that of *Lonchodomas carinatus* since small developmental stages of this species are rare at locality 3, and do not occur at locality 4.

Smallest specimen (Pl. 30, figs. 26, 30) of length (sag.) 0.47 mm., maximum width 0.49 mm. Greatest width at about half the length, in front of which straight lateral margins converge slightly forward to the obliquely angulate anterolateral margin; anterior margin curved gently forward; behind greatest width shield narrows more rapidly and is rounded. Axis of width about one-third that of entire exoskeleton, subparallel sided and rounded at each end. Pleural regions curved down more steeply posterolaterally, almost vertical behind the axis; at anterolateral angle a long slim spine, a second spine on the posterior margin in line with the axial furrow; between posterior pair of spines margin is notched. Doublure narrow, extending forward to about the maximum width; in front of this point margin of the exoskeleton is sutural. Free cheeks unknown.

A slightly larger example (Pl. 30, figs. 21-24, 27; length 0.53 mm.) is similar in form but has the axis divided by a ring furrow; glabellar portion more strongly convex at the rounded anterior end, protopygidial portion more convex and slightly wider than the basal part of the glabellar portion. Posterior margin of protopygidium deeply notched between bases of spines, doublure of notch bearing a short, ventrally and inwardly directed spine on each side. Doublure extends forward only a short distance in front of posterior spine before being cut off by suture — apparently the suture in this specimen extends farther back than in the smaller one, and therefore anterior margin of pleural region of protopygidium must run outward and backward from base of glabella. Free cheek unknown.

The largest example (Pl. 30, figs. 25, 28, 29) is incomplete and apparently has the border spines broken off; it is similar in form but the glabella has a definitely clavate outline and is narrower across the basal part than across the expanded, convex, anterior part. Faint transverse furrow extends across pleural regions to divide cephalic from protopygidial portion; thus anterior margin of protopygidium is transverse and pleural region is longer (exs.) and wider.

Degree 0. Ampyx virginiensis is rare at locality 16, yet one specimen (Pl. 31, figs. 1, 2) is a degree 0 raphiophorid, and seemingly belongs to this species. Glabella now outlined by shallow axial furrows, sloping steeply posteriorly to the narrow (sag. and exs.), faintly defined occipital ring, anteriorly projecting forward over the cephalic margin (the outline of which is concave medially) and continued by a thick, forwardly directed glabellar spine; shallow depression in side of glabella immediately in front of occipital ring. Fixed cheek gently convex, sloping steeply anterolaterally, bent down along posterior margin but the posterior border not defined. Fixed cheeks united in front of glabella by narrow (sag.) preglabellar area. Fixed cheeks and preglabellar area bounded by facial suture, which on the left side has the characteristic slight inward curvature, and continues around the posterolateral corner. Free cheeks and hypostome unknown. Transitory pygidium more than twice as wide as long, curved down (sag. and exs.) so that posterior part slopes vertically; axis stands above pleural regions, divided by shallow ring furrows into two gently convex rings and a more convex terminal portion; pleural region flat in a transverse direction, narrow raised rim, narrow border curled under as a narrow doublure.

Cephalon. Smallest cranidium (Pl. 31, figs. 3-5; length excluding glabellar spine 0.3 mm., maximum width 0.69 mm.; length glabellar spine 0.49 mm.) subsemicircular in outline, ovoid glabella with rounded median ridge and steeply sloping sides, deep, round pit immediately in front of distal part of low occipital ring, glabellar spine long, round in section, curved slightly down in lateral view. Ala occupies inner one-third of area of cheek, is gently convex, outlined by shallow alar and axial furrows. Posterior border faintly indicated distally by depression. Facial suture curves around posterolateral corner of fixed cheek and course is faintly indented in lateral margin.

Next largest cranidium (Pl. 31, figs. 7-9; length excluding glabellar spine 0.45 mm., maximum width 0.94 mm.) has anteromedian part of glabella higher and more convex so that it projects farther forward, the glabellar spine is straight, ala is more distinctly outlined, and posterior border furrow is complete, ending distally in a pit. Free cheek shows the lateral and anterior borders and border furrows, is relatively narrow (tr.) compared to larger specimens (apparently because of the lesser inward curvature of the suture laterally), and has a backwardly curving librigenal spine. The doublure is narrow.

In cephala up to a length (sag., excluding glabellar spine) of 1.5 mm. (Pl. 31, figs. 6, 10-20) the glabella becomes slightly more convex and the frontal spine upcurved. The depression in front of the occipital ring becomes recognizable as the basal muscle area, and in cephala of length 1.42 mm. or more the second and the anterior areas are visible (Pl. 31, fig. 15). The ala persists as a convex area in the inner corner of the cheek, connected by a low ridge to the extremity of the occipital ring, but becomes progressively smaller. The facial suture curves more strongly inward across the lateral part and the cheek, and the free cheek becomes wider (tr.); the proximal part of the librigenal spine becomes straight and outwardly and backwardly directed. Granulation, present on the external surfaces of cephala of length (sag.) 0.52 mm. (Pl. 31, figs. 6, 10), where it is coarsest on the free cheek, becomes finer. Beyond a length (sag.) of 1.4

mm. there is little change in the cephalon, except that the ala disappears; a trace of it in the form of a low ridge connecting the inner corner of the cheek to the extremity of the axial ring is visible in cephala of length 3 mm. and slightly larger. The smallest known hypostomes do not differ greatly from the largest.

A size series of transitory and true pygidia, believed to be that of *Ampyx virginiensis*, is shown in Plate 31, figures 21-32. The corresponding series of *Lonchodomas carinatus* (Pl. 33, figs. 7, 10, 13, 15, 18, 20, 21, 25) is quite similar, especially at the smaller sizes, and such transitory pygidia of these two species are not readily separated. Pygidia of length (sag.) 0.69 mm. (Pl. 31, figs. 31, 32) of *A. virginiensis* differ from larger examples (Pl. 30, figs. 14, 16, 17, 20) in the presence of the second, third, and faint fourth pleural furrows (each one directed more strongly backward), in showing faint interpleural grooves, and in possessing the rim. Following the series through progressively smaller sizes, the convex axial rings become more clearly defined by ring furrows having a distal pit, the outline becomes more rounded, the border narrower and the rim stronger. In the two smallest specimens (Pl. 31, figs. 21-24) a posterior indentation appears, and in the smallest of these only two axial rings and a bulbous terminal portion are visible, and the pleural regions are bent down posteriorly. The characteristic bow-shaped outline of the external margin of the border, seen in posterior view, is present throughout the series. This smallest transitory pygidium (Pl. 31, figs. 21, 22) is larger than that of the degree 0 specimen (Pl. 31, figs. 1, 2), and differs in exhibiting pleural furrows and a more acute angle between the outline of the anterior and lateral margins.

Genus LONCHODOMAS Angelin, 1854

LONCHODOMAS CARINATUS Cooper, 1953

Plates 32, 33; Text-figure 8

Figured Material. All in USNM

Geological Horizon and Localities. Lower Edinburg limestone, localities 2, 3, 5, 6, and Willow Grove, 3 miles south of Woodstock, Shenandoah Co., Virginia.

Description. Cephalon (Pl. 32, figs. 1, 4, 5, 7) excluding spines triangular in outline, about twice as wide as long. Glabella subdiamond-shaped in outline; occipital ring a narrow (sag.) band, not separated by axial furrow from posterior border and not raised above the adjacent part of the border, posterior margin gently arcuate backward; occipital furrow extremely shallow; in front of this furrow glabella becomes moderately convex, with a median longitudinal carina from which the gently convex sides slope steeply down, maximum width in front of the mid-length, anterior part drawn out into a long, tapering, frontal glabellar spine which is directed horizontally with an extremely slight upward curvature, the spine square in cross section, each corner of the square projecting slightly to form a longitudinal ridge, the two ridges on the upper surface running back to join and merge into the carina, the two ridges on the lower surface being continuous with the anterolateral edge of the cephalon; muscle areas on the glabella (darker areas, smooth externally — Pl. 32, fig. 23; Pl. 33, figs. 31, 32; Text-fig. 8a) include a small oval area in the distal part of the occipital furrow, in front of this a subtriangular area, the posterior part of which extends up the side of the glabella quite close to the carina, confluent with this a third elongate-oval area disposed longitudinally on the glabella about half way up the slope; a fourth poorly defined area is situated on the slope of the glabella just inside the anterior pit. The anterior area was not observed in *Lonchodomas rostratus* (Whittington, 1950b, fig. 7) but may be seen in *Lonchodomas* sp. of Størmer (1949, p. 178, fig. 14b). There seems no evidence for the subdivision of the basal and median areas shown by Hupé (1953, p. 72, fig. 26, *3*). Axial furrows not distinct, limits of glabella ill-defined by change in slope and by the deep elongate anterior pit which is situated opposite the maximum width of the glabella.

Cheek subtriangular in outline, sloping anterolaterally, inner part gently convex, outer part sloping less steeply towards the acutely angulate margin (Pl. 32, fig. 1) so that in profile there is a gentle concavity; posterior border sloping steeply forward, posterior border furrow commencing a short distance outside the occipital ring and ending just inside the facial suture in a deep pit; at about half its width the posterior border is bent down to slope gently outward; librigenal spine thick, hook-shaped, ending in a sharp point, prismatic in cross section, each edge raised to form a strong ridge, the surfaces between the ridges concave.

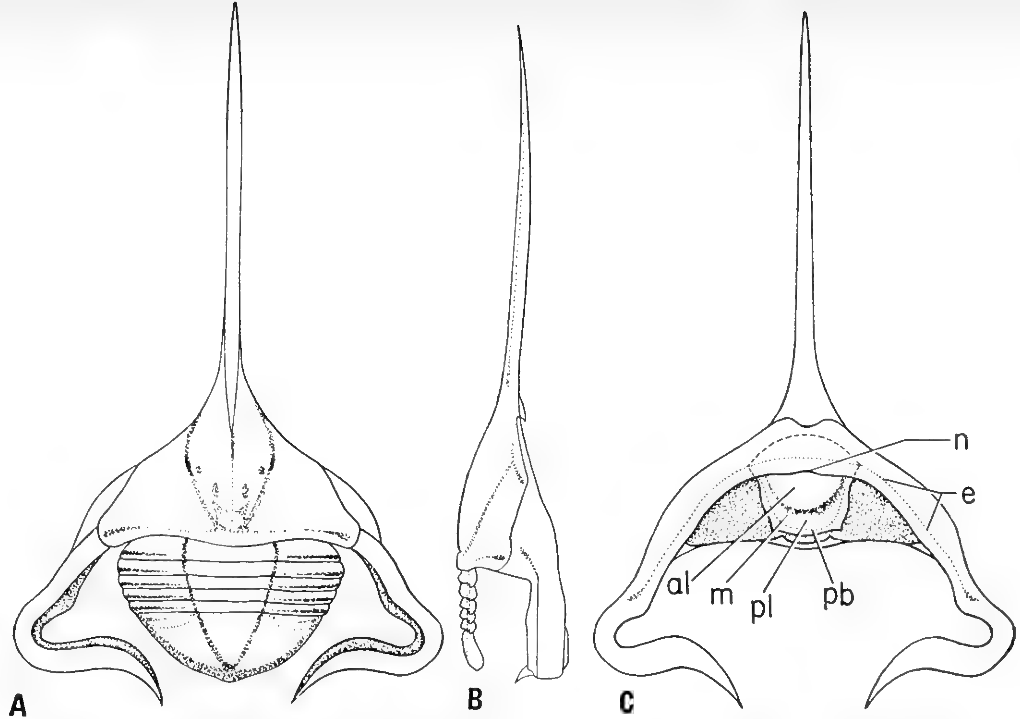

Figure 8. *Lonchodomas carinatus* Cooper, 1953. Reconstructions, A, dorsal, B, right lateral, C, ventral views. Approximately X 2½. Abbreviations: *al*, anterior lobe of middle body of hypostome; *e*, edge of elevated inner part of cephalic doublure; *m*, macula; *n*, notch in inner margin of cephalic doublure; *pb*, posterior border of hypostome; *pl*, posterior lobe of middle body of hypostome.

The lower, outer ridge of the spine continuous with the acutely angulate anterolateral border of the cheek, the lower, inner ridge dying out as it approaches the genal angle, the upper, outer ridge dying out over the genal angle of the cheek, the upper, inner ridge continuous with the sharp edge of the posterior border.

The facial suture crosses the posterior margin at about three-quarters the width of the posterior border, runs at first outward and slightly forward, then in an 'S' curve across the posterior border and the outer part of the cheek, reaching the anterolateral margin almost directly in line (exs.) with the point at which it crossed the posterior margin; from here the suture runs along the acutely angulate margin of the cephalon toward the midline, the two branches meeting on the under side of the frontal glabellar spine in a double curve with a median sinus (Pl. 32, figs. 2, 3, 5; Text-fig. 8c); these curves give a characteristic outline to the anterior margin of the doublure. Doublure broadest anteriorly where it is gently convex ventrally, anterolaterally about as wide as the librigenal spine; outline of the inner margin a smooth semicircular curve, interrupted by a shallow median anterior notch (*n* in Text-fig. 8c); a short distance inside this margin is a flexure (*c* in Text-fig. 8c) so situated that the narrow inner part of the doublure projects slightly ventrally below the wider, flat, outer part (compare Pl. 32, figs. 2, 3).

Hypostome (Pl. 32, figs. 6, 8, 9, 12, 17; Text-fig. 8e) subhexagonal in outline, in ventral aspect flexed along the midline so that the sides slope steeply from the rounded median part. Anterior lobe of middle body subcircular in outline, reaching anterior margin in the midline, anterolaterally curving down to flattened border; near base of small triangular anterior wing this border passes into the gently convex lateral border; lateral border furrow deep just behind anterior wing, becoming shallower posteriorly and running into middle furrow; posterior border a narrow convex band, bearing raised lines, margin gently curved convexly posteriorly; macula a small, slightly raised oval area situated midway along middle furrow; posterior lobe of middle body crescentic in outline, flattened. Margin of borders bent down but not curled under to form a doublure; posterior wing a small rounded projection from this bent-down margin at the posterolateral angle, margin excavated between the wings. The outline and curvature of the transverse median part of the anterior edge of the hypostome is such that it will not fit exactly against the inner edge of the cephalic doublure (compare figs. 6, 9 with figs. 2, 3, Pl. 32). Further, these edges are not thick and sharply transected as are, for example, the edges of the cheek along the dorsal facial suture. This suggests that the anterior edge of the hypostome did not lie against the inner edge of the cephalic doublure along a hypostomal suture. The hypostome may have been attached only by musculature to the dorsal cephalic exoskeleton. If the exoskeleton is reconstructed with the tip of the anterior hypostomal wing lying close to the anterior boss, then the anterior part of the hypostome lay both above and in front of the cephalic doublure, as suggested in Text-figure 8c.

External surface of occipital ring and median lobe of glabella (excluding the muscle areas) and posterior part of the cheek bearing closely and irregularly spaced small pits (Pl. 32, fig. 23); similar pitting may be visible on the middle body of the hypostome. Anastomosing raised lines run longitudinally on the rounded angles of the frontal glabellar spine, the librigenal spine, and the anterolateral edge of the cephalon; similar lines on the outer surface of the inner, ventrally projecting part of the cephalic doublure, and on the lateral and posterior borders of the hypostome. The exoskeleton is thin and differently colored over the hypostomal maculae.

Number of thoracic segments unknown, but presumed in the reconstruction (Text-fig. 8a, b) to be five as in other species of this genus. A few isolated segments have been obtained (Pl. 32, figs. 10, 11, 13-15). Axis about one-third of the width, gently convex, ring flattened and with slight convexity distally; articulating furrow narrow and deep, articulating half ring short (sag.), as is the doublure of the axial ring. Inner part of pleura horizontal, at fulcrum bent down vertically, outer part short, with a narrow doublure rolled closely underneath. Pleural furrow narrow and deep, commencing a short distance out from the axial furrow. Axial and fulcral articulating processes present, a small facet on the anterolateral area of the outer part of the pleura, and a small depression in the posterolateral part of the doublure. These segments are extremely like those of *Ampyx virginiensis* (Pl. 30, figs. 6-13) but may readily be separated by the flatness of the axial ring, narrowness of the articulating and pleural furrows, etc. These segments also match, and fit with, the posterior border of the cephalon and the pygidium of *Lonchodomas carinatus.*

Pygidium (Pl. 32, figs. 18, 19, 21, 22) three times as wide as long, anterior margin straight, transverse, posterolateral margins rounded; gently convex axis tapering and extending back to inner margin of border, inner part of pleural regions horizontal, outer parts bent down to form a steeply sloping border, this border projecting in a gentle convexity behind the axis. Deep articulating furrow and short (sag.) articulating half ring, first axial ring indicated by its slight convexity; behind this ring axis subdivided only by the paired muscle areas; there are two pairs of muscle areas in each ring furrow, a larger outer transversely ovate area, and a smaller inner area, the inner pair being joined across the midline by a narrow band; up to nine ring furrows are indicated by these pairs of muscle areas. Pleural furrows narrow, deep, with a forwardly concave outline; first pleural furrow visible on all specimens, commencing a short distance outside the axis and extending to the inner margin of the border; on some specimens the second, third, and fourth pleural furrow may be seen, each furrow directed outwards and slightly more strongly backwards. Small facet. Outer edge of border thickened, rounded, doublure not extending beneath border; in posterior view the outline of the border having a deep median notch. Axis of pygidium and adjacent part of pleural regions pitted in some specimens, fine, anastomosing raised lines on the outer parts of the thoracic pleurae and the border of the pygidium.

Discussion. Lonchodomas carinatus was described by Cooper (1953, pp. 17-18, pl. 7, figs. 12-17, 19-23), the holotype coming from the present locality 2. Material from the other localities mentioned here appears to be identical with that from locality 2. The cranidium, thorax and pygidium of *L. carinatus* are extremely like those of the type species *L. rostratus* (Whittington, 1950b, pp. 556-557, pl. 74, figs. 11-15, text-fig. 7), which comes from beds in Norway of the same age as the lower Edinburg formation. *L. carinatus* cannot be compared with *L. sublaevis* Raymond (1925, pp. 40-41, pl. 2, figs. 11, 12,) because the type material is too poor for any comparison, nor can it be compared with *L. punctatus* Cooper (1953, p. 18, pl. 4, figs. 20-21) because only the pygidium of this species has been described in detail. The type material of *L. politus* Raymond (1925, pp. 39-40, pl. 2, figs. 8-10), consisting of two cranidia and a pygidium, cannot be distinguished from specimens of the same size in the present material. However, the free cheek of *L. politus* is not known, hence it is uncertain whether or not the librigenal spine had the hooked form characteristic of *L. carinatus*. I hesitate to regard *L. carinatus* as a synonym of *L. politus* without this information. Cranidia and pygidia from Tennessee identified by Cooper (1953, Pl. 6, figs. 1, 2, 5-8, 10) as *L. politus* differ from *L. carinatus* in that the carina is absent on the anterior part of the glabella, there are no pits in the external surface of the fixed cheek, and the pleural regions of the pygidium slope in toward the axial furrows and the distal parts of the external surface exhibit more pleural furrows.

In species of *Lonchodomas* from Scotland and Oklahoma (Whittington, 1950b, p. 557) the librigenal spine is long and gently curved, rather like the corresponding spine in *Ampyx*. Through the kindness of Professor Marshall Kay I have examined material attributed to *Lonchodomas halli* (Billings, 1861) from the Youngman formation, Highgate Springs, Vermont (Kay, 1958, p. 83). Cranidia and pygidia of this Middle Ordovician species are associated with free cheeks bearing a librigenal spine having much the same form as that of *L. carinatus*. An associated hypostome is also like that of the Virginia species. Evidently *L. halli* from Highgate Springs, Vt. (one of Billings' type localities) is a species closely related to *L. carinatus*, and these two species are the only ones so far known with these peculiar hooked librigenal spines. According to Cooper (1956, pp. 31-32, Chart 1) the Youngman is of the same age as the early Edinburg limestone.

Development

One enrolled degree 1 exoskeleton (Pl. 33, figs. 1-4, 7), lacking free cheeks, and isolated cranidia of similar size (Pl. 33, figs. 5, 6, 8) are known. Length of glabella of latter (excluding frontal spine) 0.65 mm.; width of cranidium 1.35 mm. Glabella subdiamond-shaped in outline, moderately convex, with a rounded crest from which the flattened sides slope steeply, occipital ring gently convex, backwardly projecting, occipital furrow shallow medially, represented distally by faint depressions; anterior part of glabella extended into a long, gently upwardly curving frontal glabellar spine, this spine suboval in cross-section; in lateral view two raised longitudinal ridges on the proximal part of the frontal glabellar spine; these ridges unite distally, proximally they run on to the anterior part of the glabella and die out. Fixed cheeks gently convex, triangular in outline, posterior border defined only in the outer part by a shallow posterior border furrow that is deepest just inside the facial suture; in lateral view facial suture only slightly bowed inwards along lateral margin of fixed cheek, anteriorly two branches confluent and bounding anterior margin of glabella. Thoracic segment relatively long (sag. and exs.), convex axial ring and pleural furrow becoming deepest distally; outer part of pleura short (tr.), bent down vertically, fulcrum running in a curve outward and backward so that the anterolateral margin of the segment fits closely beneath the bent-down posterolateral portion of the fixed cheek (Pl. 33, fig. 3). Transitory pygidium three times as wide as long, axis gently convex, divided obscurely into two rings and a wider (tr.) rounded, gently convex, posterior part. Pleural region horizontal beside anterior part of axis, posterolateral and posterior parts curved downwards so that close to, and behind, the axis they slope almost vertically, and in this region there is a shallow median notch in the outline; first pleural furrow shallow, faint interpleural groove, second and third pleural furrows extremely faint; narrow raised rim.

Larger cranidia (original of Pl. 33, figs. 9, 11, 12, of width 1.8 mm., of Pl. 33, figs. 14, 16, 17, of width 2.4 mm.) have been associated with free cheeks of appropriate size. The frontal glabellar spine is now subsquare in cross-section, each side excavated and a ridge running longitudinally along the angle, the spine itself with a reduced upward curvature, almost straight. The surface of the frontal lobe of the glabella below the base of the spine is now flat rather than convex, and where it is bounded by the suture it has assumed the characteristic outline of the holaspis. The free cheek and doublure are thus much like those of larger specimens, except that in the smaller specimen (Pl. 33, fig. 11) that part of the free cheek outside the suture is relatively narrower (tr.), and the librigenal spine is bent, not hooked, so that the proximal portion runs outward and backward, the distal portion slightly inward and backward. In the larger specimen (Pl. 33, fig. 16) the free cheek has approximately the form of the adult, being wider (tr.), and the librigenal spine has assumed the hooked form and subsquare cross-section, though the hook is not quite so acute as in the larger specimens. A transitory pygidium of width 1.65 mm. (Pl. 33, figs. 10, 13, 15) has the axis tapering back, six rings outlined by ring furrows which become progressively fainter posteriorly, and three pleural furrows. The rim is less pronounced than at degree 1 (Pl. 33, fig. 7), the outline posterolaterally smoothly curved; in posterior view the border shows the deep and acute posterior notch. An enrolled exoskeleton of degree 4, lacking the free cheeks (Pl. 33, figs. 19, 22, 23, 26, 29, 30; the second thoracic segment lies edgewise between the first and third, the extremity of the left pleura being visible in the ventral view — Pl. 33, fig. 29) has the cranidium much like that of larger specimens. The four thoracic segments decrease in length (sag. and exs.) posteriorly, and in the last three segments the fulcrum is directed progressively more strongly inward as well as backward. The transitory pygidium is partly concealed in this specimen, but an isolated example of similar size (Pl. 33, figs. 18, 21) has four axial rings and three pairs of pleural furrows visible.

Cephala up to the largest size obtained (Pl. 32, figs. 1, 4, 5, 7, 16, 20) show little further change, the glabella becoming slightly more convex in longitudinal profile, and the lateral concavity in the facial suture slightly more pronounced. Pygidia of larger size (Pl. 33, figs. 20, 25; Pl. 32, figs. 18, 19, 21, 22) likewise show little change, the pleural furrows become decidedly concavely-curved forward, and the median notch in the border slightly shallower.

Genus AMPYXINA Ulrich, 1922

Type Species. Endymionia bellatula Savage, 1917. Redescribed by Whittington, 1950b, p. 557, pl. 73, figs. 7-8. At that time it was not realized that the type specimens were in the U. S. National Museum, numbered 72140. The original of Plate 34, figure 1, an external mould in which the posterior part of the cranidium conceals much of the first thoracic segment, is the holotype.

Discussion. Besides the type and the two species described below, others placed here come from England, Scotland and Sweden (Whittard, 1955, p. 25). Because of the different ways in which these specimens are preserved it is difficult to make comparisons, or to be sure of such features as the convexity and lobation of the glabella, and nature and disposition of the lateral glabellar furrows. The glabella in the type species is rather wider than that of other species, the basal glabellar lobes are represented by shallow oval pits, and the alae merge at the inner posterior corner into the extremity of the occipital ring. In *A. powelli* (Pl. 34, figs. 3-13), *A. wothertonensis* Whittard, 1955 (pl. 3, figs. 1-4), and *A. lanceola* n.sp. (Pl. 35, fig. 32) three pairs of lateral glabellar furrows appear as subcircular shallow pits. The alae in *A. powelli* and *A. lanceola* (Pl. 34, figs. 15, 16) are like those of the type species, whereas in *A. wothertonensis* and *A. aldonensis* (Pl. 28, fig. 13) they appear to be completely cut off from the occipital ring and posterior border by a furrow, perhaps because the latter specimens are internal moulds. In the pygidium the nature of the ribs between the pleural furrows appears to vary — in the type species and *A. wothertonensis* these ridges are broad and flat-topped, whereas in *A. powelli* and *A. lanceola* n.sp. (Pl. 34, figs. 25-27) they are narrow with steeply sloping sides. It is shown here (Pl. 35) that a frontal glabellar spine is present in the development of *Ampyxina*. There is no sign of this spine in the largest specimens of some species, but in *A. lanceola* n.sp. there is a short frontal glabellar spine in the largest specimens, as there is in *A. aldonensis* (Reed, 1935) (this paper, Pl. 28, figs. 11, 13).

AMPYXINA POWELLI (Raymond, 1920)

Plate 34, figures 3-13; Plate 35, figures 1-25.

Raphiophorus powelli Raymond, 1920, pp. 276-277; Raymond, 1925, pp. 32-33, pl. 2, figs. 1, 2.

Ampyxina scarabeus Butts, 1941, p. 75, pl. 82, figs. 1-3; Cooper and Cooper, 1946, pl. 3, figs. 11, 12.

Ampyxina powelli, Cooper, 1953, pp. 13-14, pl. 4, figs. 1-9, 12(?).

Holotype. Museum of Comparative Zoology, no. 1598, from the Edinburg formation, Liberty Hall facies, Catawba Valley, Va.

Figured Material. USNM, from Lower Edinburg limestone, localities 5 and 14.

Description. The new material makes possible the following additions to Cooper's description: —

Occipital ring narrow (sag. and exs.), strongly convex (Pl. 34, figs. 10, 12, 13), in dorsal view curved convexly backward. Occipital furrow deep, curving forward distally and ending against the side of the deep, subcircular, basal glabellar furrow (on the inner surface, Plate 34, figure 6, this lateral glabellar furrow appears as a low, circular, raised area). In front of occipital ring, glabella expands forward to maximum width adjacent to the anterolateral cephalic border, frontal lobe gently rounded; anterior part of glabella moderately convex, that part in front of occipital ring strongly convex, sloping steeply to occipital furrow at basal glabellar furrow. Second and third (from the posterior) lateral glabellar furrows appear as small, suboval, slightly depressed areas over which the exoskeleton is thinner (these thin areas are broken through on right side of original of Plate 34, figure 3); the second situated opposite the anterior end of the ala, the third a short distance behind the anterior pit, both adjacent to the shallow axial furrow. Anterior pit deep (Pl. 34, figs. 6, 10, 13). Frontal lobe of glabella overhangs anterior cephalic border, and is separated from this border by a shallow preglabellar furrow (Pl. 34, fig. 12).

Ala (referred to by Cooper, 1953, p. 13, as basal lateral lobe of glabella) gently convex, of length (sag.) about one third that of glabella (Pl. 34, figs. 3, 4, 6, 12, 13), separated from the glabella by a shallow axial furrow and from the cheek by a broad shallow alar furrow; inner posterior corner of ala merges into the posterior border adjacent to the occipital ring; outer, posterior part of ala separated from posterior border by a shallow posterior border furrow. Cheek (Pl. 34, figs. 7, 8, 10-13) moderately convex, narrow anterolateral border defined by a deep border furrow which dies out, both as it approaches the anterior branch of the suture and the base of the librigenal spine; posterior border furrow curves forward distally so that the posterior border widens, furrow expands into shallow pit just inside facial suture; cheeks united in front of glabella by narrow (sag. and exs.) convex frontal area. Facial suture curves around pit at extremity of posterior border furrow and runs inward and forward across the cheek with a slight sinuosity, the two branches meeting in a smooth curve along the anterior border. Librigenal spine arises from outer and upper surface of cheek at genal angle, is long and tapering, and curves to run directly backward beyond the pygidium. A narrow doublure (Pl. 34, figs. 7, 8), not crossed by median or connective sutures, unites the free cheeks anteriorly; this doublure is horizontal anterolaterally and anteriorly, and a shallow groove runs just inside the smoothly curved inner margin; beneath the base of the librigenal spine the doublure narrows and there is no doublure along the inner part of the posterior border.

Three specimens of a hypostome (Pl. 34, figs. 5, 9) attributed to this species occur with the abundant material at locality 14. Outline subrectangular, slightly wider than long, anterolateral portion projecting slightly laterally; middle body moderately convex, most strongly so anteromedially. Narrow convex border becomes defined at outer part of anterior margin and curves around to follow lateral and posterior margins. An oval, longitudinally elongate, gently convex area situated inside the posterolateral border. Margins of border bent up vertically but not curled under to form a doublure. Small projection from posterolateral part of this margin forms posterior wing. Margin of border between wings excavated in shallow notch.

Thorax (Pl. 34, figs. 3, 4) of five segments, the anterior markedly longer (sag. and exs.) than the succeeding four, which are progressively shorter backward. Axis about one-quarter the width, axial rings narrow (sag.), convex, curved arcuately backward, articulating furrow deep, with deep appendiferal pit situated a short distance inside the axial furrow. Articulating half ring absent on first segment, on succeeding four segments about as long (sag.) as the axial ring. Pleurae extend out horizontally, are flexed down distally, and at the fulcrum a narrow (tr.) portion is bent down vertically and curled under to form an extremely narrow doublure. Pleural furrow of first segment curved convexly forward, on succeeding segments directed transversely, becoming deeper on outward sloping portion. Outer parts of pleurae facetted, facet received by depression in doublure of preceding segment. Pygidium (Pl. 34, figs. 3, 4) with axis reaching back to margin of inner part of pleural regions, border bent down steeply, in posterior view a median notch in the margin. Four to six axial rings outlined by ring furrows which are deepest distally; five pairs of pleural furrows which deepen distally are successively directed more strongly backward and have a distal flexure.

External surface smooth, except for anastomosing raised lines on border of cephalon and outer parts of pleurae of thorax and pygidium.

Development

Smallest known specimens are isolated cranidia (Pl. 35, figs. 1-3), of width (tr.) 0.69 mm. Glabella suboval in outline, moderately convex, the flattened sides sloping from the rounded keel; narrow occipital ring, large deep subcircular basal furrow; frontal lobe prolonged into a thick frontal glabellar spine. Posterior border of convex fixed cheek defined only distally by a pit; ala cannot be distinguished. Next largest specimen is a complete exoskeleton (lacking the hypostome) of degree 2 (Pl. 35, figs. 5, 6, 10, 11). The glabella has a long frontal spine, the alae are well defined by axial and alar furrows, and merge with the innermost part of the posterior border; outside the ala is the posterior border furrow; librigenal spine long and directed backward. First thoracic segment longer than the second and having the characteristic forward curve of the pleural furrow. On the pygidium three axial rings and three pairs of pleural furrows may be distinguished, the pleural furrows straight, lacking the distal backward curve. External surface granulate, a row of short spines along the cephalic doublure, similar spines on the posterior border just inside the base of the librigenal spine.

In exoskeletons of degree 3 (Pl. 35, figs. 4, 7-9) the glabella is sharply keeled, but in exoskeletons of degree 4 (Pl. 35, fig. 12) the keel is less sharp. In small holaspides (Pl. 35, figs. 13, 14) the frontal glabellar spine is about one-quarter the length (sag.) of the remainder of the glabella, the pleural furrows of the pygidium have the characteristic distal backward curve, the external surface is granulate, and there are still short spines on the posterior border just inside the base of the librigenal spine. In the largest holaspides (Pl. 34, figs. 3, 10-13) the frontal glabellar spine may be absent or may be represented by a small tubercle; the external surface appears smooth and there is no trace of the short spines.

AMPYXINA LANCEOLA n.sp.

Plate 34, figures 14-28; Plate 35, figures 26-35.

Ampyxina elegans Cooper, 1953 (part), USNM 116443a,b, originals of Cooper's plate 4, figures 10, 11 (reproduced at X8, not X4, as stated by Cooper).

Holotype. USNM 137692 (Pl. 34, figs. 14-17, 22), locality 16.

Other Material. Paratypes USNM 137693a-c; all figured material in U. S. National Museum.

Geological Horizon and Localities. Lower Edinburg limestone, locality 16; Effna limestone, four miles southwest of Bland Court House, Va.

Description. This species occurs quite commonly at locality 16 and may be distinguished from *Ampyxina powelli* by the following characters:

Glabella (compare Pl. 34, figs. 14-17, 22, with Pl. 34, figs. 10, 12, 13) more convex, in dorsal aspect projecting farther in front of the cephalic border, and in the largest specimens bearing a short frontal glabellar spine about one-quarter the length of the rest of the glabella; portion of glabella in front of the occipital ring stands relatively higher and slopes down more steeply to the occipital furrow. Basal lateral glabellar furrow represented by a deep sub-circular pit; in front of this two further furrows (Pl. 35, fig. 32) are faintly discernible as oval areas over which the exoskeleton is thinner, and are situated a short distance up the side of the glabella; the anterior is the smaller. Alar furrow broader and deeper, and the ala is more inflated, separated from the posterior border by the posterior border furrow; this furrow becomes extremely faint behind the inner, posterior corner of the ala, so that here the ala merges into the extremity of the occipital ring. Lateral border of the cheek less strongly curved outside and just in front of the librigenal spine, consequently the free cheek is relatively narrower (tr.) (compare Pl. 34, figs. 14, 15 with Pl. 34, figs. 10, 13). Lateral and anterior cephalic borders narrow, convex, curled under in the narrow doublure which is convex ventrally (Pl. 34, fig. 16). Inner margin of anterior part of doublure faces upward and is rounded, not having the appearance of being a sutural junction. The well preserved specimens show clearly the anterolateral border furrow dying out as it approaches the facial suture (Pl. 34, fig. 17), only an extremely shallow border furrow crosses the anterior part of the fixed cheek, and the preglabellar furrow runs into the axial furrow and separates the glabella from the anterior border.

Pygidium (compare Pl. 34, figs. 25, 27, with Pl. 34, figs. 3, 4) is somewhat more triangular in outline, for the axis and adjacent part of the pleural regions project slightly posteriorly; pleural furrows deeper and broader, especially distally, so that they are separated by narrower, sharper ridges. External surface finely granulate, in some specimens slightly coarser granules on the posterior part of the glabella and a row of tiny spines (Pl. 34, fig. 21) along the posterior margin of the occipital ring and posterior border.

The small cranidia of *A. lanceola* (Pl. 35, figs. 26-29, 32, 35) differ from those of comparable size of *A. powelli* (Pl. 35, figs. 17-24) mainly in the higher glabella and stouter frontal spine. Small pygidia (Pl. 35, figs. 30, 31, 33, 34) differ in outline and in the width of the distal part of the pleural furrows.

Discussion. A cranidium and pygidium placed in *Raymondella elegans* by Cooper (1953, pl. 4, figs. 10, 11) are here placed in *Ampyxina lanceola* n.sp.

The type material of *Ampyxina aldonensis* (Reed, 1935) (Pl. 28, figs. 10, 11, 13) from strata of comparable age in Scotland, shows that this species is extremely similar to *A. lanceola,* particularly in the outline of glabella, the presence of the frontal glabellar spine, the convexity of the alae, and the curvature and width of the pleural furrows of the pygidium.

Genus RAYMONDELLA Reed, 1935

Discussion. The type species, *Raymondella macconochiei* (Nicholson and Etheridge, 1879), has been redescribed (Whittington, 1950b, pp. 558-559, pl. 74, fig. 10; pl. 75, figs. 1, 2), and *R. elegans* Cooper, 1953 is remarkably similar to it. Among raphiophorids *Raymondella* (Pl. 36) seems most closely related to *Ampyxina* (Pls. 34, 35), as comparison between illustrations will show. *Raymondella* differs from *Ampyxina* in form of the glabella (compare Pl. 36, figs. 1-5 with Pl. 34, figs. 1-17, 22) in front of the occipital ring — the basal part is narrow, sloping upwards, and expanding rapidly into a spherical frontal portion which projects and overhangs well in front of the anterior cephalic border; the basal lateral glabellar furrow is a subcircular, deeply impressed pit lying immediately in front of the outer part of the occipital ring; in front of this furrow the glabella expands rapidly. The ala is smaller, subcircular in outline and defined by a deep, broad, alar furrow which runs backward and slightly outward from the axial furrow to the posterior border furrow. The convex cheek of *Raymondella,* inside the border furrows, is crossed by raised anastomosing ridges, a type of sculpture that is not known in *Ampyxina.* Axial rings of thorax and pygidium (compare Pl. 36, figs. 24-26, 29-32, 33, 34, 37, with Pl. 34, figs. 1, 3, 4, 18-20, 25-27) more convex, articulating furrows and appendiferal pits deeper, pleural furrows deeper, and that of the first thoracic segment (Pl. 36, figs. 24-26) lacking the curve convex forward of *Ampyxina* (Pl. 34, figs. 3, 18), pleural furrows of pygidium wider distally and separated by narrow, high ridges.

RAYMONDELLA ELEGANS (Cooper, 1953)

Plate 36

Ampyxina elegans Cooper, 1953 (part), p. 14, pl. 4, figs. 14, 15, 16, 18, and 19. The originals of Cooper's figures 10 and 11, plate 4, are here referred to *Ampyxina lanceola* n. sp., and those of his figures 13 and 17, plate 4, to the pygidium of *Tretaspis sagenosus* n. sp.

Holotype. USNM 116445C, a cranidium from the present locality 7.

Figured Material. USNM 116446, original of Cooper, 1953, pl. 4, fig. 16; additional material figured here, in U. S. National Museum.

Geological Horizon and Localities. Lower Edinburg formation, localities 3, 7, 16; Cherry Grove, 4 miles northwest of Linville Station, Rockingham Co., Va.

Description. Largest cranidium here figured (Pl. 36, figs. 1-5) of maximum width 3.25 mm. Occipital ring narrow (sag. and exs.), convex, gently arcuate backward; deep, wide, occipital furrow passes distally into the subcircular pit of the basal lateral glabellar furrow; between these furrows glabella narrow, convex, stalklike, in front of these furrows expanding rapidly into the subspherical median and frontal portions, which project forward and downward over the anterior border; maximum width at about two-fifths the length. Short, blunt, frontal glabellar spine situated on the vertical anterior slope, axial furrow and anterior pit deep.

Alar furrow diverges from the axial furrow at a point about opposite two-thirds the length of the glabella, and runs backward and slightly outward to the posterior border furrow, outer slope steep. Between the alar and axial furrows a triangular area is defined which is depressed below the fixed cheek, and is gently convex only at the inner posterior corner; this convex portion is subcircular in outline and is here termed the ala. The posterior border furrow becomes shallower as it passes inward behind the ala, and thus the inner posterior corner of the ala is separated by only a slight depression from the extremity of the occipital ring. Cheek convex, sloping steeply anterolaterally to the narrow convex border, which is defined by a deep border furrow; border furrow becomes shallow as it approaches the facial suture, narrow convex anterior border separated from the glabella by the deep preglabellar furrow. Two branches of facial suture confluent anteriorly along the margin of the border, laterally having a sinuous course across the cheek. Librigenal spine originates from the posterolateral border and upper posterolateral surface of the cheek, and curves to run directly backward. Cephalic doublure narrow laterally and anteriorly, convex ventrally, absent along posterior border and beneath occipital ring. Hypostome unknown. Posterior border convex, bent down distally, posterior border furrow deep, a distal pit just inside the point where it is crossed by the facial suture.

Only isolated thoracic segments known (Pl. 36, figs. 24-26, 29-32). The anterior segment can be recognized by the curved outline of the anterolateral part of the pleura where it fits beneath the posterior cephalic border. Other segments have a rectangular outline to the distal part of the pleura. Axial ring narrow (sag. and exs.) and convex, articulating furrow deep, appendiferal pit deep and elongate, situated a short distance in from the axial furrow, appendifer a thick triangular projection. Pleural furrow deep and broad, running out transversely, flanked by convex ridges. Outer part of pleura bent down gently, the outermost part flexed vertically and curled under to form a narrow doublure. Anterolateral angle of pleura facetted, and doublure with a depression to receive the facet of the following segment during enrollment. Pygidium (Pl. 36, figs. 33, 34, 37) four times as wide as long (sag.), convex axis divided by deep furrows into four rings. Inner part of pleural region horizontal, deeply excavated by three pleural furrows that widen rapidly distally, these furrows separated by strong interpleural ridges which run outward and backward to join the rim. Border bent down almost vertically, outline of outer edge in posterior view sinuous, with a median notch. Doublure extremely narrow.

External surface of glabella, axial rings, and ridges of thorax and pygidium granulate, the granules coarsest in a row along the occipital and axial rings, the posterior cephalic border, and the posterior ridge of the thoracic pleurae. Cheek inside border furrows crossed by raised, anastomosing lines which run subparallel to the anterolateral margin. On the cephalic doublure, the outer parts of the pleurae, and on the border of the pygidium, raised lines run subparallel to the margin.

Discussion. The pygidium attributed to *Raymondella elegans* by Cooper (1953, p. 14, pl. 4, figs. 13, 17) is considered here to be that of *Tretaspis sagenosus* n.sp. These two species occur together at localities 3, 7, and 16, *Tretaspis sagenosus* occurring rarely at a few other localities. The associations of exoskeletal parts made here are based on morphological comparisons between occipital ring and posterior border of cephalon, and thoracic segments and pygidia. They seem to be upheld by the likeness between the pygidium of *R. elegans* and the type species, and the likeness between the pygidium of *Tretaspis sagenosus* n.sp. and that of other species of this genus.

Cooper (1953, p. 14) states that the width of the holotype cranidium is 4.8 mm. This figure may have been printed in error, since, using the magnifications given in his plate 4, figures 14, 15, 18 and 19, the width of the holotype cranidium appears to be about 3.5 mm. The largest specimens I have seen in both Cooper's and my material are of about this size.

Another species of *Raymondella,* from the Oranda formation, Chambersburg, Pa., is that described by Cooper (1953, pp. 14-15) as "*Ampyxina* sp." The cranidium is typical, but the glabella (Pl. 28, figs. 15, 16, 19) appears to differ from that of *R. elegans* in having flattened sides and a rounded median keel.

Development

A size series of cranidia from a width of about 1.0 mm. to 3.5 mm. is known. The smallest cranidia (Pl. 36, figs. 18, 19, 22,

23) are like those of comparable size of other raphiophorids (Pl. 31, figs. 7-9; Pl. 35, figs. 5, 6, 10, 11), the glabella clavate, pinched in in front of the occipital ring by the basal glabellar furrows, frontal lobe projecting beyond the anterior border and continued by a thick, straight, frontal glabellar spine. A relatively large triangular area is enclosed between the alar and axial furrows, and the posterior border furrow is shallow. As size increases (Pl. 36, figs. 16, 17, 21; 10, 15, 20; 12-14; 8, 9; 6, 7, 11), the most conspicuous changes occur in the glabella. In the early stages the glabella is keeled, with flat, steeply sloping sides. As the part in front of the basal glabellar furrows swells up to become subspherical, the median portion becomes higher and rounded in transverse section, the transverse profile changing from triangular to circular; the frontal part of the glabella bulges forward and downward over the anterior border, and the frontal glabellar spine is progressively reduced to the short, blunt-tipped spine of the largest cranidia. The posterior border furrow becomes deeper with increasing size, and at all times it seems to separate the inner posterior convex portion of the ala from the posterior border.

The smallest known pygidia (Pl. 36, figs. 27, 28) differ from the largest in not exhibiting the fourth axial ring.

External surface of cephalon in the small stages granulate, row of tiny spines around the anterior and lateral margin. In the larger specimens the surface is similar, except that on the cheek granulation has fused to form the anastomosing lines.

Family ENDYMIONIIDAE Raymond, 1920

Genus SALTERIA Thomson, 1864

SALTERIA AMERICANA Cooper, 1953

Plate 28, figures 9, 12, 14, 17, 18

Discussion. Cooper (1953, pp. 12-13, pl. 3, figs. 8-10) based this species on material from the lower part of the Liberty Hall facies of the Edinburg limestone in Rockingham and Pulaski counties, Va. A few additional silicified specimens have been obtained from the present locality 14.

Occipital ring is extremely narrow (sag. and exs.); the "raised posterior carina" is not evident. In front of the preglabellar furrow is a narrow (sag. and exs.) preglabellar field, separated by a shallow anterior border furrow from the narrow anterior border. No trace of genal caeca. Cranidium bounded by facial suture which runs forward in a curve convex outward across the posterior border, and then forward and slightly inward across the cheek in a sinuous course, reaching the anterior border outside the projected line of the axial furrow and running along the margin of this border. Free cheek and cephalic doublure unknown.

Thorax of 7 segments, the anterior segment the longest (sag. and exs.). Pleurae inflated, inner part horizontal, crossed by a deep, narrow, pleural furrow which runs in a curve concave forward and deepens distally. Distal part of pleurae bent down in two stages, the first sloping gently outward, the outermost part, beyond the end of the pleural furrow, narrow (tr.) and bent down vertically. Pygidium more than twice as wide as long (sag.). Pleural regions with a broad, shallow, border furrow outside which is a convex border, the outermost part of this border narrow and sloping almost vertically. Six pairs of deep, narrow pleural furrows running in curve concave forwards, dying out at the inner margin of the border furrow. Doublure of thoracic pleurae and pleural regions extremely narrow, being merely the tightly rolled-under edge of the exoskeleton. Sculpture of the external surface of the exoskeleton not well preserved, but fine raised lines run along the doublure of the pygidium.

As Cooper (1953, p. 13) pointed out, this species is exceedingly like the type species *Salteria primaeva,* from the Balclatchie beds, lower Middle Ordovician, Scotland (Reed, 1903, pp. 43-44, pl. 4, figs. 13, 14). I have placed this genus in the family Endymioniidae, but the cephalon of *Salteria* resembles that of *Seleneceme* (Whittington, 1952a, p. 4, pl. 2, fig. 13) in the subcircular outline of the glabella, narrowness (sag.) of the occipital ring, breadth of the posterior cephalic border, and course of the facial suture.

REFERENCES

Butts, C.

1941. Geology of the Appalachian Valley in Virginia, Part 2, fossil plates and explanations. Virginia Geol. Surv., Bull. 52, pp. 1-271, pls. 1-135.

COOPER, B. N.
1953. Trilobites from the Lower Champlainian formations of the Appalachian Valley. Geol. Soc. Am., Mem. 55, pp. 1-69, pls. 1-19, 2 figs., table.

COOPER, B. N. and G. A. COOPER
1946. Lower Middle Ordovician stratigraphy of the Shenandoah Valley, Virginia. Geol. Soc. Am., Bull., vol. 57, pp. 35-114, pls. 1-3, 9 figs.

COOPER, G. A.
1956. Chazyan and related brachiopods. Smithsonian Misc. Coll., vol. 127 (in two parts), pp. 1-1245, pls. 1-269.

EVITT, W. R.
1951. Some Middle Ordovician trilobites of the families Cheiruridae, Harpidae and Lichidae. Jour. Paleont., vol. 25, pp. 587-616, pls. 85-88, 1 fig.
1953. Observations on the trilobite *Ceraurus*. Jour. Paleont., vol. 27, pp. 33-48, pls. 5-8, 1 fig.

EVITT, W. R. and H. B. WHITTINGTON
1953. The exoskeleton of *Flexicalymene* (Trilobita). Jour. Paleont., vol. 27, pp. 49-55, pls. 9, 10, 1 fig.

HUPÉ, P.
1953. Classe des Trilobites. *In* Traité de Paléontologie, vol. 3, pp. 44-246, Ed. J. Piveteau. Paris.

KAY, M.
1958. Ordovician Highgate Springs sequence of Vermont and Quebec and Ordovician classification. Amer. Jour. Sci., vol. 256, pp. 65-96, figs. 1-11.

KOBAYASHI, T.
1951. On the Ordovician trilobites in Central China. Jour. Fac. Sci. Univ. Tokyo, sec. 2, vol. 8, part 1, pp. 1-87, pls. 1-5.

LINDSTRÖM, G.
1901. Researches on the visual organs of the trilobites. K. Svenska Vet.-Akad. Handl., vol. 34, no. 8, pp. 1-86, pls. 1-6.

LU, Y. H.
1957. Trilobita. *In* Index Fossils of China, Invertebrate, part 3, pp. 249-294, pls. 137-155. Geological Press, Peking.

ÖPIK, A.
1926. Beiträge zur Kenntnis der Kukruse-(C_2) Stufe in Eesti. I. Pub. Geol. Inst. Tartu, no. 4, pp. 1-18, pls. 1, 2.
1937. Trilobiten aus Estland. Pub. Geol. Inst. Univ. Tartu, no. 52, pp. 1-163, pls. 1-27.

RAYMOND, P. E.

1920. Some new Ordovician trilobites. Mus. Comp. Zool., Bull., vol. 64, no. 2, pp. 273-296.

1925. Some trilobites of the Lower Middle Ordovician of eastern North America. Mus. Comp. Zool., Bull., vol. 67, no. 1, pp. 1-180, pls. 1-10.

REED, F. R. C.

1903. The Lower Palaeozoic trilobites of the Girvan District, Ayrshire, Part 1. Paleontogr. Soc., London, pp. 1-48, pls. 1-6.

1935. The Lower Palaeozoic trilobites of the Girvan District, Ayrshire, Supp. No. 3. Paleontogr. Soc., London, pp. 1-64, pls. 1-4.

ROSS, R. J.

1948. Revisions in the terminology of trilobites. Amer. Jour. Sci., vol. 246, pp. 573-577.

1951. Ontogenies of three Garden City (early Ordovician) trilobites. Jour. Paleont., vol. 25, pp. 578-586, pls. 81-84.

1953. Additional Garden City (early Ordovician) trilobites. Jour. Paleont., vol. 27, pp. 633-646, pls. 62-64.

RUEDEMANN, R.

1901. Trenton conglomerate of Rysedorph hill and its fauna. N. Y. State Mus., Bull. 49, pp. 3-114, pls. A, B, 1-7.

1916. The cephalic suture lines of *Cryptolithus* (*Trinucleus* auct.). N. Y. State Mus., Bull. 189, pp. 144-148, pl. 35, figs. 43-46.

SAVAGE, T. E.

1917. The Thebes Sandstone and Orchard Creek shale and their faunas in Illinois. Trans. Illinois Acad. Sci., vol. 10, pp. 261-275, pls. 1, 2.

SKJESETH, S.

1955. The Middle Ordovician of the Oslo Region, Norway, 5, the trilobite family Styginidae. Norsk. Geol. Tids., vol. 35, pp. 9-28, pls. 1-5.

STÄUBLE, A.

1953. Two new species of the family Cryptolithidae. Natur. Canadien, vol. 80, pp. 85-119, 201-220, figs. 1-24.

STØRMER, L.

1930. Scandinavian Trinucleidae with special reference to Norwegian species and varieties. Vid.-Akad. Oslo, Skr. I, Mat.-Naturv. Klasse, no. 4, pp. 1-111, pls. 1-14, 47 figs.

1940. Early descriptions of Norwegian trilobites. Norsk. Geol. Tids., vol. 20, pp. 113-151, pls. 1-3.

1949. Classe des Trilobites. *In* Traité de Zoologie. Directed by P.-P. Grasse, Masson et cie, Paris, vol. 6, pp. 160-197, figs. 1-24.

THORSLUND, P.
1940. On the Chasmops series of Jemtland and Södermanland (Tvären). Sveriges Geol. Under., ser. C, no. 436, pp. 1-191, pls. 1-12, 56 figs., map.

TRIPP, R. P.
1954. Caradocian trilobites from mudstones at Craighead Quarry, near Girvan, Ayrshire. Royal Soc. Edinburgh, Trans., vol. 62, part 3 (no. 16), pp. 655-693, pls. 1-4.

WARBURG, E.
1925. The trilobites of the Leptaena limestone in Dalarne. Geol. Instit. Upsala, Bull., vol. 17, pp. 1-446, pls. 1-11, 23 figs.

WHITTARD, W. F.
1955. The Ordovician trilobites of the Shelve Inlier, West Shropshire, Part 1. Paleontogr. Soc., London, pp. 1-40, pls. 1-4.

WHITTINGTON, H. B.
1941a. The Trinucleidae — with special reference to North American genera and species. Jour. Paleont., vol. 15, pp. 21-41, pls. 5, 6, 1 fig.
1941b. Silicified Trenton trilobites. Jour. Paleont., vol. 15, pp. 492-522, pls. 72-75, 13 figs.
1949. *Dolichoharpes* and the origin of the harpid fringe. Amer. Jour. Sci., vol. 247, pp. 276-285, pls. 1, 2.
1950a. British trilobites of the family Harpidae. Paleontogr. Soc., London, pp. 1-55, pls. 1-7, figs. 1-16.
1950b. Sixteen Ordovician genotype trilobites. Jour. Paleont., vol. 24, pp. 531-565, pls. 68-75, figs. 1-9.
1952a. The trilobite family Dionididae. Jour. Paleont., vol. 26, pp. 1-11, pls. 1-2, fig. 1.
1952b. A unique remopleuridid trilobite. Breviora, Mus. Comp. Zool., no. 4, pp. 1-9, pl. 1.
1956. Silicified Middle Ordovician trilobites: the Odontopleuridae. Mus. Comp. Zool., Bull., vol. 114, no. 5, pp. 155-288, pls. 1-24, figs. 1-25.
1957. The ontogeny of trilobites. Biol. Rev., vol. 32, pp. 421-469, figs. 1-29.
1959. Trilobita. *In* Treatise on Invertebrate Paleontology, Part O, Arthropoda 1. Direct. and Ed. Raymond C. Moore, Geol. Soc. Amer. and Univ. Kansas Press, pp. O38-O560, figs. 27-415.

WHITTINGTON, H. B. and W. R. EVITT
1954. Silicified Middle Ordovician trilobites. Geol. Soc. Am., Mem. 59, pp. 1-137, pls. 1-33, 27 figs.

WHITTINGTON, H. B. and ALLEN S. HUNT
1958. Growth of the cephalon of *Cryptolithus* (Trilobita) (Abstract). Geol. Soc. Amer., Bull., vol. 69, p. 1662.

EXPLANATION OF PLATES 1-36

To make the photographs, the larger specimens were mounted on insect pins with gum arabic, the smaller specimens laid on a black surface. A light coating of ammonium chloride was used. Stereoscopic pairs of views were made by tilting the specimen, and only the left-hand view of a pair is numbered. The heads and shafts of the pins have been blacked out; otherwise the photographs have not been retouched. It is arbitrarily decided that the plane passing through the margin of the occipital or axial ring shall run in the dorsoventral direction, and views are described accordingly. Exterior or interior views have been taken in a direction lying in the sagittal plane to give the fullest possible view of the exoskeletal surface. Oblique exterior or interior views have been taken in directions at an angle to the sagittal plane. The initials USNM refer to the U.S. National Museum, Washington, D.C., the initials HM to the Hunterian Museum, Glasgow, Scotland, and the initials MCZ to the Museum of Comparative Zoology. These initials are followed by the catalogue numbers.

PLATES

PLATE 1

Remopleurides caelatus n.sp.
Lower Edinburg formation

Figure	
1, 2	Holotype cranidium, dorsal, anterior views, X 15. USNM 137675. Locality 2.
3, 5, 6, 7, 8	Cranidium: anterior, dorsal, ventral, posterior, right lateral views, X 6. Locality 2.
4, 16	Paratype free cheek: dorsal, oblique exterior views, X 6. USNM 137676a. Locality 6.
9	Hypostome: right lateral view, X9. Locality 2.
10, 11, 12	Free cheek and paratype hypostome: ventral, anteroventral, dorsal views, X 9. Locality 2.
13, 14, 15	Paratype hypostome: oblique interior, posterior views, X 9; posterodorsal view, X 15. USNM 137676b. Locality 2.

PLATE 1

PLATE 2

PLATE 2

Remopleurides caelatus n.sp.
Lower Edinburg formation

Figure	
1, 2, 3, 4, 5	Paratype thoracic segment: anterior, dorsal, posterior, ventral, left lateral views, X 9. USNM 137676c. Locality 15.
6, 7, 8, 9, 10	Paratype, two articulated thoracic segments: dorsal, anterior, ventral, posterior, right lateral views, X 9. USNM 137676d. Locality 15.
11, 12, 13	Paratype, posterior four thoracic segments and pygidium, articulated: right lateral, dorsal views, X 9; ventral view, X 7. USNM 137676e. Locality 6.
14, 16	Pygidium: dorsal, posterior views, X 9. Locality 2.
15, 17	Pygidium: dorsal, posterior views, X 9. Locality 2.
18	Posterior four thoracic segments and pygidium, articulated: dorsal view, X 6. Locality 6.
19, 21	Posterior thoracic segment and pygidium, articulated: dorsal view, X 15; posterior view, X 9. Locality 2.
20	Pygidium: dorsal view, X 15. Locality 2.
22	Part of paratype free cheek: exterior view, X 30. USNM 137676a. Locality 6.
23	Cranidium and left free cheek: oblique interior view, X 9. Locality 2.
24	Detail of left free cheek, original of figure 23: interior view showing cone extending inward from pit in external surface, X 30. Locality 2.
25	Detail of tongue of cranidium, original of figure 23: interior view showing pit in anterior boss, X 30. Locality 2.

PLATE 3

Remopleurides caelatus n.sp.
Lower Edinburg formation

Figure	
1, 2, 3, 4, 5	Protaspis: dorsal, posterior, ventral, lateral views; oblique exterior stereograph, X 30. Locality 6.
6	Broken posterior portion of protaspis: oblique exterior view, X 30. Locality 3.
7, 9	Degree 0 cranidium: ventral, dorsal stereographs, X 30. Locality 6.
8, 11, 15	Degree 0 transitory pyigidium: ventral, right lateral, dorsal views, X 30. Locality 6.
10, 12, 13, 14	Degree 0 transitory pygidium: right lateral, dorsal, posterior, ventral views, X 30. Locality 2.
16	Meraspid cranidium, locality 2: free cheek, locality 3: dorsal stereograph, X 30.
17, 18	Small free cheek: dorsal, ventral views, X 15. Locality 16.

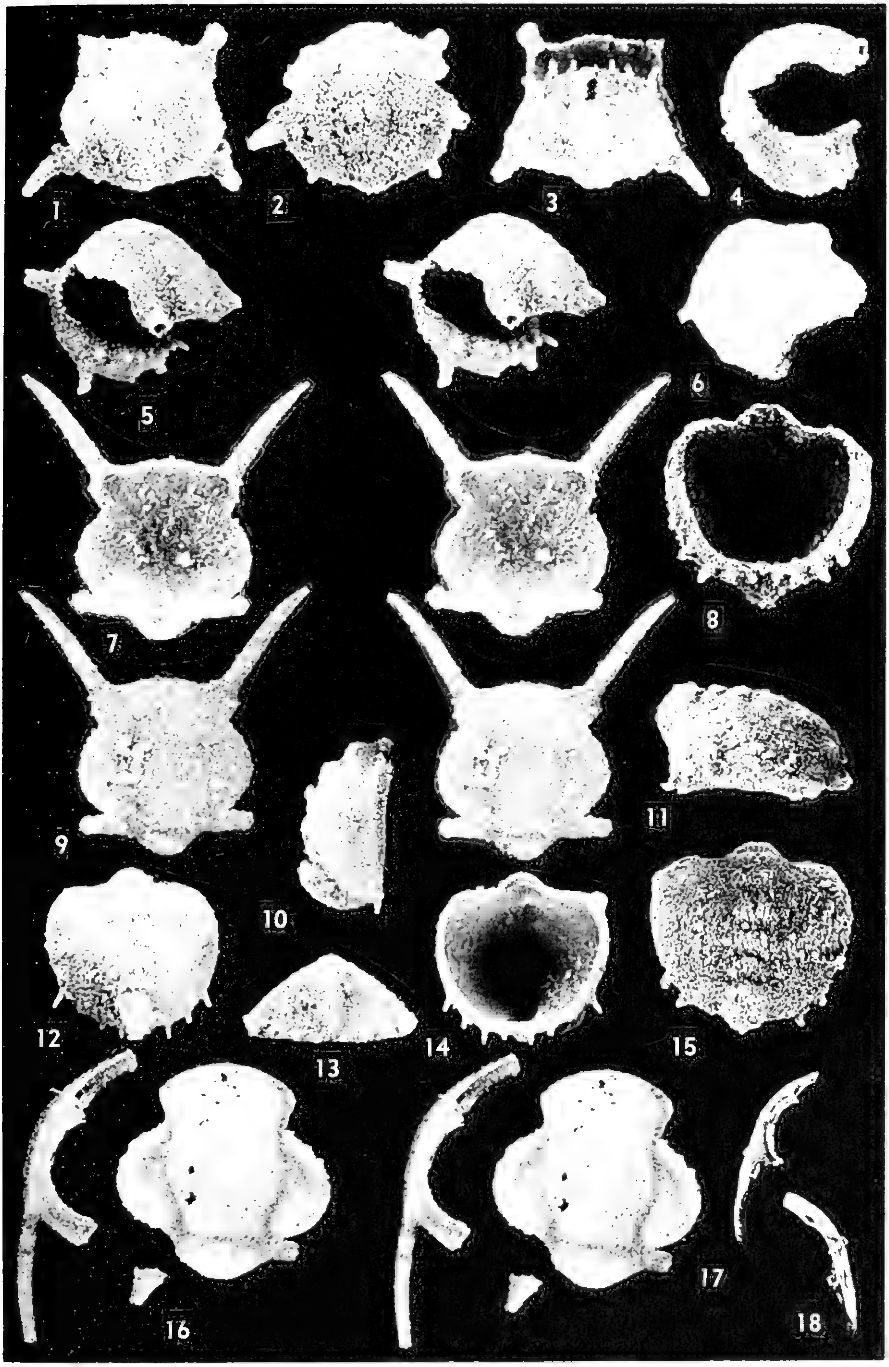

PLATE 3

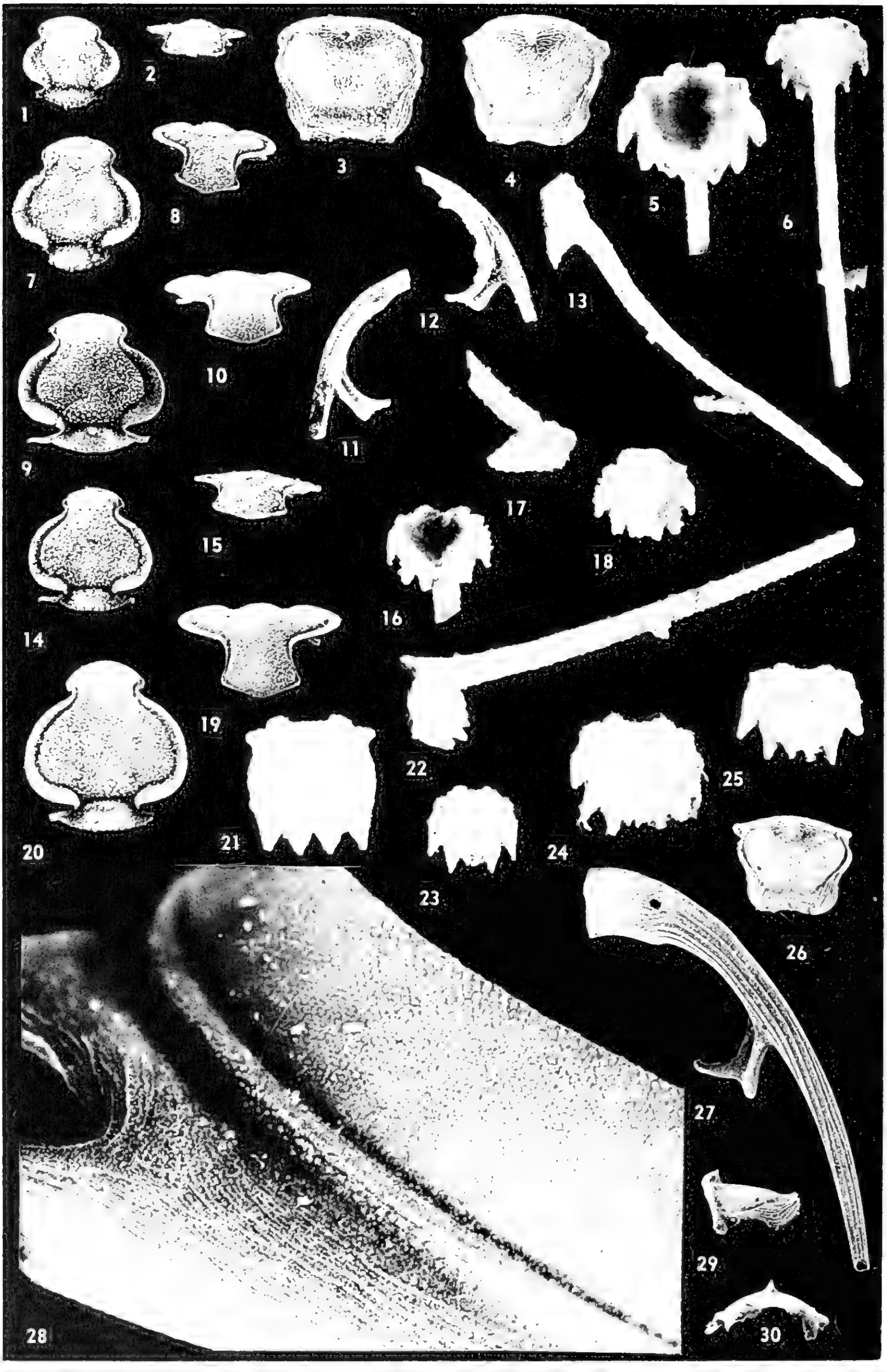
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PLATE 4

PLATE 4

Remopleurides caelatus n.sp.
Lower Edinburg formation

Figure	
1, 2	Small cranidium: dorsal, anterior views, X 15. Locality 6.
3	Small hypostome: exterior view, X 15. Locality 6.
4	Small hypostome: exterior view, X 15. Locality 2.
5	Degree 5? transitory pygidium: ventral view, X 30. Locality 3.
6, 13	Degree 5? transitory pygidium: dorsal, left lateral views, X 30. Locality 3.
7, 8	Small cranidium: dorsal, anterior views, X 15. Locality 6.
9, 10	Small cranidium: dorsal, anterior views, X 15. Locality 2.
11, 12	Small free cheek: ventral, dorsal views, X 15. Locality 15.
14, 15	Small cranidium: dorsal, anterior views, X 9. Locality 6.
16, 17, 18	Degree 6? transitory pygidium: ventral, right lateral, dorsal views, X 30. Locality 3.
19, 20	Small cranidium: anterior, dorsal views, X 9. Locality 6.
21	Small holaspid pygidium: dorsal view, X 30. Locality 2.
22	Degree 7? transitory pygidium: anterolateral view, X 30. Locality 3.
23	Transitory pygidium: dorsal view, X 30. Locality 3.
24	Degree 9? transitory pygidium: dorsal view, X 30. Locality 3.
25	Transitory pygidium: dorsal view, X 30. Locality 3.

Remopleurides plaesiourus n.sp.
Lower Martinsburg limestone, locality 9

26, 29, 30	Paratype hypostome: exterior, left lateral, posterior views, X 6. USNM 137678b.
27	Paratype free cheek: ventral view, X 6. USNM 137678d.
28	Part of paratype free cheek, oblique exterior view showing eye surface, X 30.

PLATE 5

Remopleurides plaesiourus n.sp.
Lower Martinsburg shale

Figure	
1, 2	Cranidium: dorsal, ventral (photographed under alcohol to show thinner exoskeleton over muscle areas) views, X 6. Locality 9.
3, 4, 5	Holotype cranidium: anterior, right lateral, dorsal views, X 6. USNM 137677. Locality 9.
6, 7	Paratype free cheek: dorsal, oblique exterior views, X 6. USNM 137678d. Locality 9.
8	Pygidium: dorsal view, X 9. Locality 10.
9	Pygidium: dorsal view, X 9. Locality 10.
10	Paratype eighth (?) thoracic segment, dorsal view, X 6. USNM 137678a. Locality 9.
11	Paratype thoracic segments: exterior view, X 6. USNM 137678e. Locality 9.
12, 13, 14	Paratype posterior thoracic segment and pygidium: right lateral, dorsal, ventral views, X 6. USNM 137678c. Locality 10.
15	Pygidium: dorsal view, X 15. Locality 10.
16, 17	Degree 0 cranidium: exterior, interior views, X 30. Locality 10.
18, 19, 20, 26	Protaspis: dorsal, posterior, left lateral, oblique ventral views, X 30. Locality 10.
21, 22, 23	Degree 0 transitory pygidium: exterior, right lateral, posterior views, X 30. Locality 10.
24, 25	Transitory pygidium: ventral, dorsal views, X 30. Locality 10.

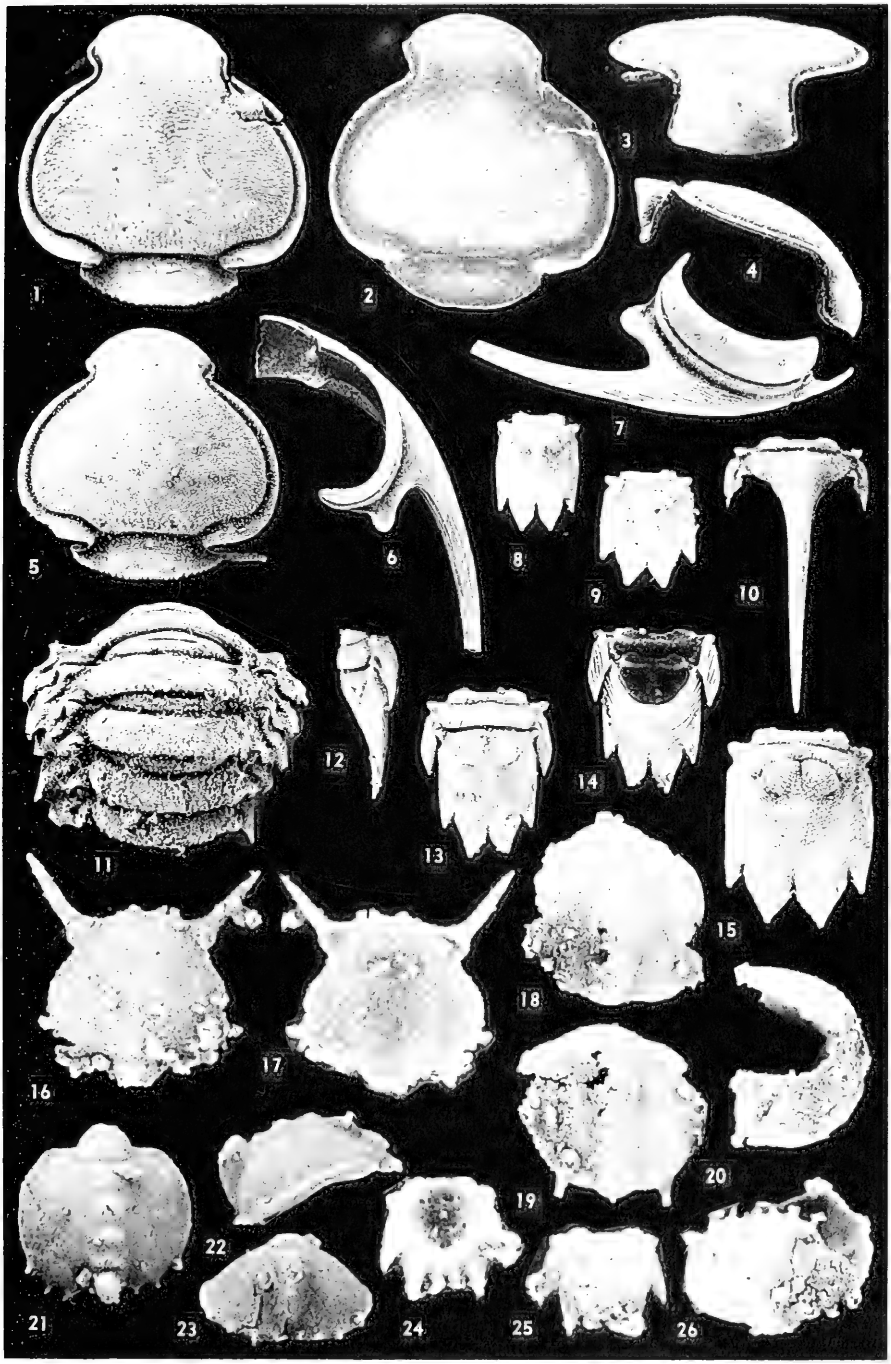

PLATE 5

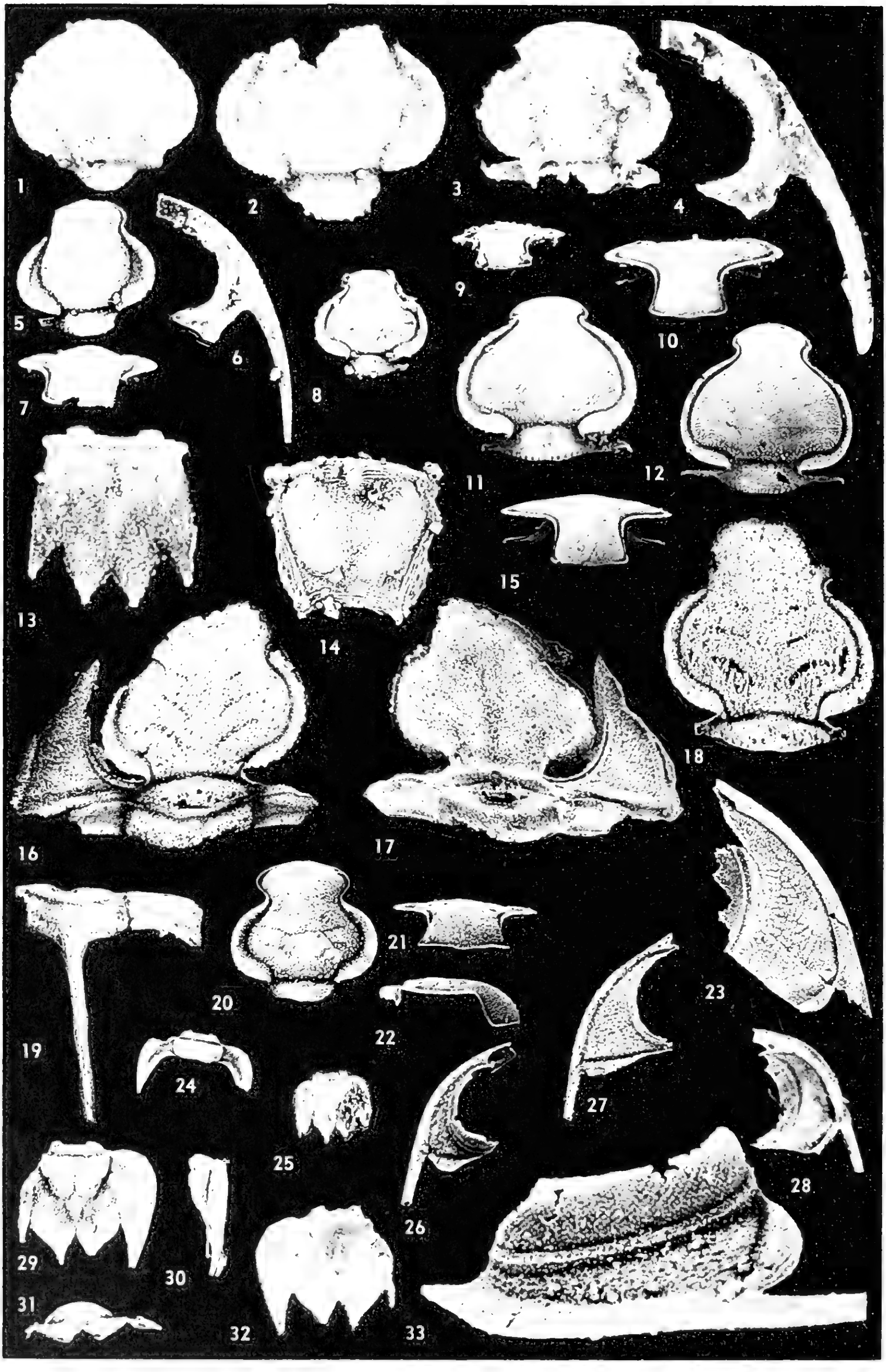
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PLATE 6

PLATE 6

Remopleurides placesiourus n.sp.
Lower Martinsburg shale, locality 10

Figure	
1	Degree 0 cranidium: exterior view, X 30.
2	Small meraspid cranidium: exterior view, X 30.
3, 4	Meraspid cranidium and free cheek: exterior view, X 30.
5, 7	Meraspid cranidium: dorsal, anterior views, X 15.
6	Meraspid free cheek: dorsal view, X 15.
8, 9	Small cranidium: dorsal, anterior views, X 9.
10, 11	Cranidium: anterior, dorsal views, X 9.
12, 15	Cranidium: dorsal, anterior views, X 6.
13	Small holaspid pygidium: dorsal view, X 30.
14	Hypostome: exterior view, X 15.

Robergiella sagittalis n.gen., n.sp.
Lower Edinburg formation (Liberty Hall facies)

16, 17	Holotype, incomplete cranidium, free cheek, first thoracic segment: exterior, interior views, X 6. USNM 137679. Locality 14.
18	Cranidium: dorsal view, X 6. Locality 14.
19	Thoracic segment: exterior view, X 6. Locality 16.
20, 21, 22	Cranidium: dorsal, anterior, right lateral views, X 9. Locality 16.
23	Free cheek: interior view, X 6. Locality 16.
24	Thoracic segment: dorsal view, X 6. Locality 16.
25	Small pygidium: dorsal view, X 9. Locality 16.
26, 28, 33	Free cheek: dorsal, interior views, X 10; lateral view, X 30. Locality 16.
27	Free cheek: exterior view, X 6. Locality 14.
29, 30, 31, 32	Paratype pygidium: dorsal, right lateral, posterior, ventral views, X 6. USNM 137680. Locality 14.

PLATE 7

Remopleurides caphyroides n.sp.
Lower Edinburg formation

Figure	
1, 3, 10	Holotype cranidium, locality 3, USNM 137681; paratype free cheek, locality 2, USNM 137682a: anterior, dorsal views, X 6; oblique exterior stereograph, X 4.
2, 8	Holotype cranidium: left lateral, ventral views, X 6. Locality 3.
4, 5, 7, 9	Paratype hypostome (USNM 137682b) and free cheek in juxtaposition: interior, exterior, oblique anterior, oblique interior views, X 4½. Locality 3.
6	Paratype free cheek: Ventral view, X 6. Locality 2.

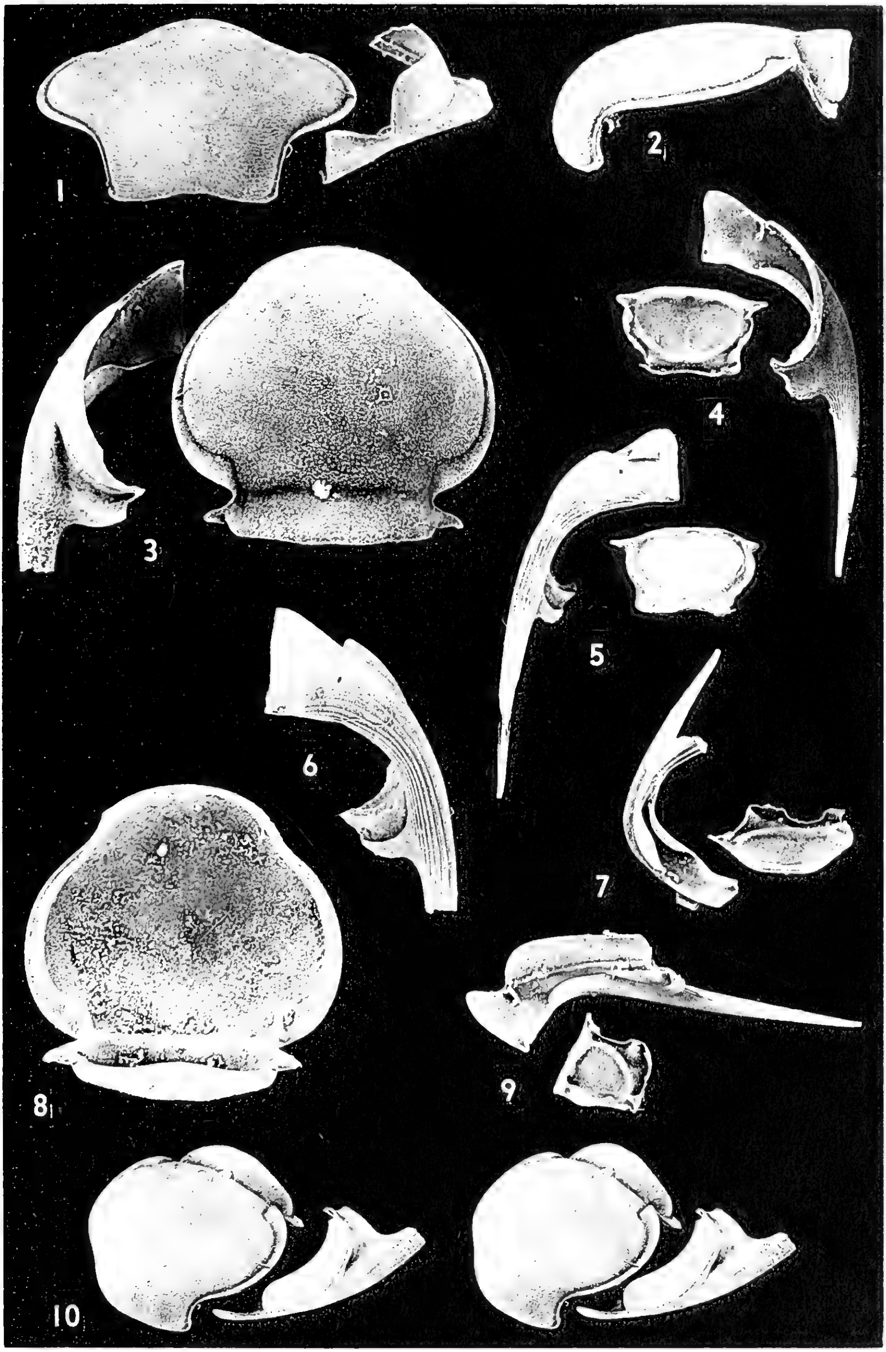

PLATE 7

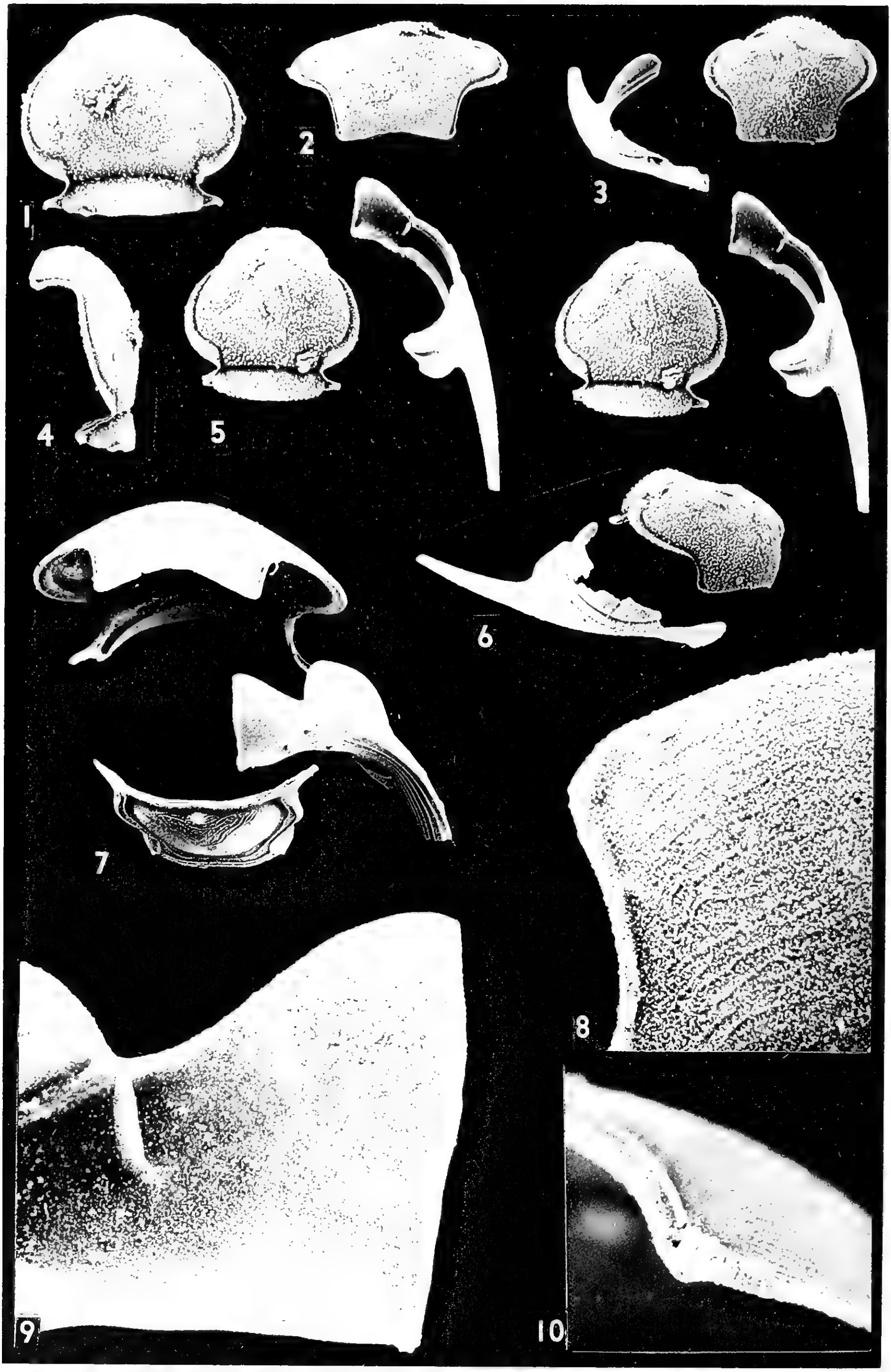

PLATE 8

PLATE 8

Remopleurides caphyroides n.sp.
Lower Edinburg formation

Figure	
1, 2, 4	Cranidium: dorsal, anterior, left lateral views, X 6. Locality 3.
3, 5, 6	Cranidium and free cheek: anterior view, dorsal stereograph, anterolateral view, X 9. Locality 3.
7	Holotype cranidium, paratype free cheek, hypostome in juxtaposition: anteroventral view, X 6. Cranidium and hypostome, locality 3; free cheek, locality 2.
8, 10	Holotype cranidium: oblique exterior view showing left side of glabellar tongue and anterior area of fixed cheek and anterior pit, oblique anterior view showing edge of glabellar tongue and anterior area of fixed cheek on right side, anterior boss in silhouette, X 30. Locality 3.
9	Free cheek: oblique interior view of doublure close to median suture, showing long cone extending inward from pit in external surface, X 15. Locality 3.

PLATE 9

Remopleurides caphyroides n.sp.
Lower Edinburg formation

Figure	
1, 2, 3, 4, 5	Paratype thoracic segment: posterior, anterior, dorsal, ventral, left lateral views, X 6. USNM 137682c. Locality 3.
6	Pygidium: dorsal view, X 9. Locality 3.
7, 8, 12	Paratype thoracic segment with median spine: dorsal, ventral, left lateral views, X 6. USNM 137682d. Locality 4.
9, 10, 11, 15	Paratype pygidium: dorsal, left lateral, ventral, posterior views, X 7. USNM 137682e. Locality 3.
13, 14	Small holaspid pygidium: dorsal, ventral views, X 9. Locality 3.
16, 17	Small hypostome: exterior, interior views, X 9. Locality 3.
18, 22	Small pygidium: dorsal, right lateral views, X 30. Locality 3.
19	Free cheek, part of eye surface and external rim of eye lobe: oblique exterior view, X 30. Locality 3.
20, 21	Hypostome: exterior, interior views, X 6. Locality 2.

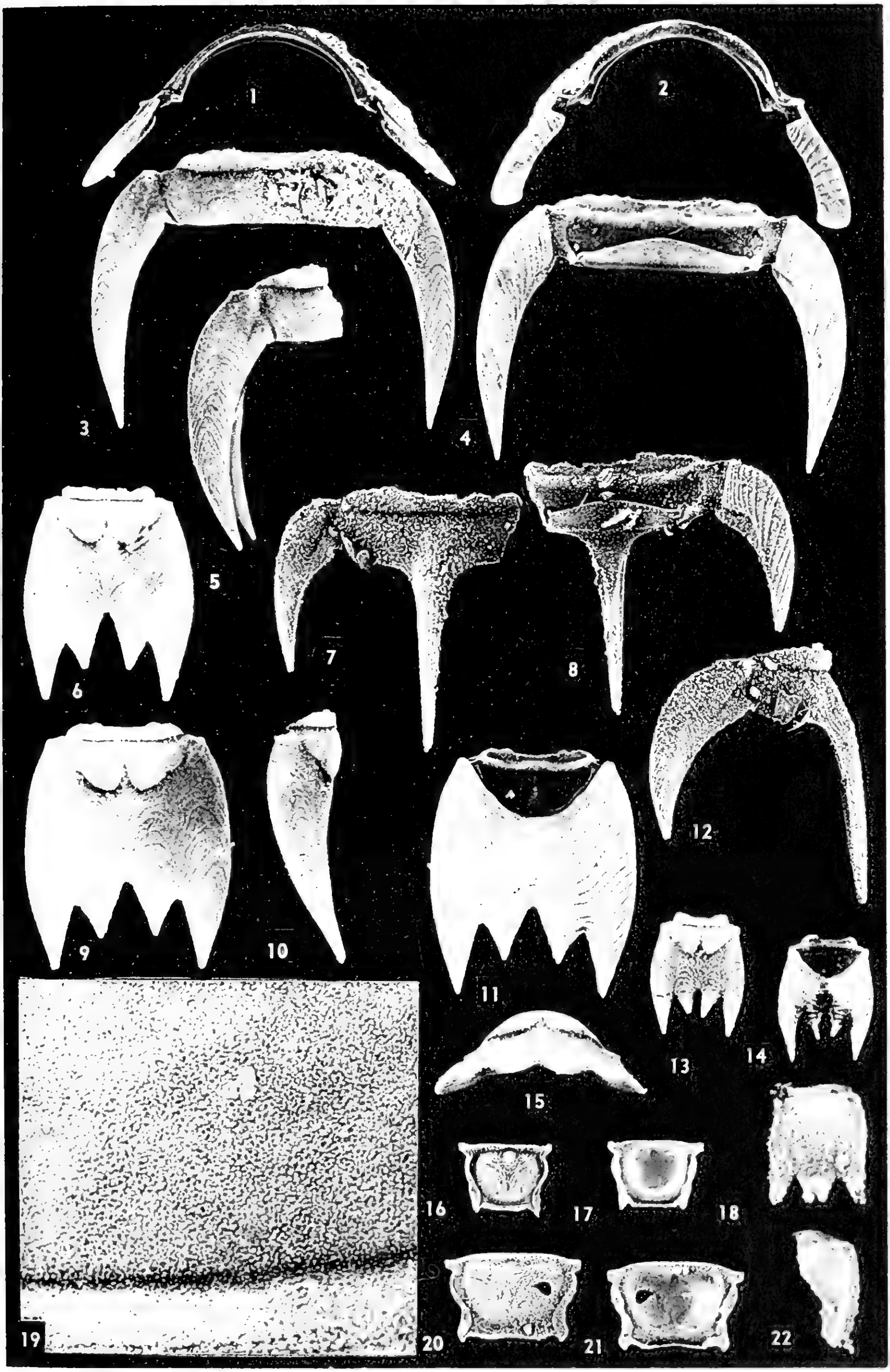

PLATE 9

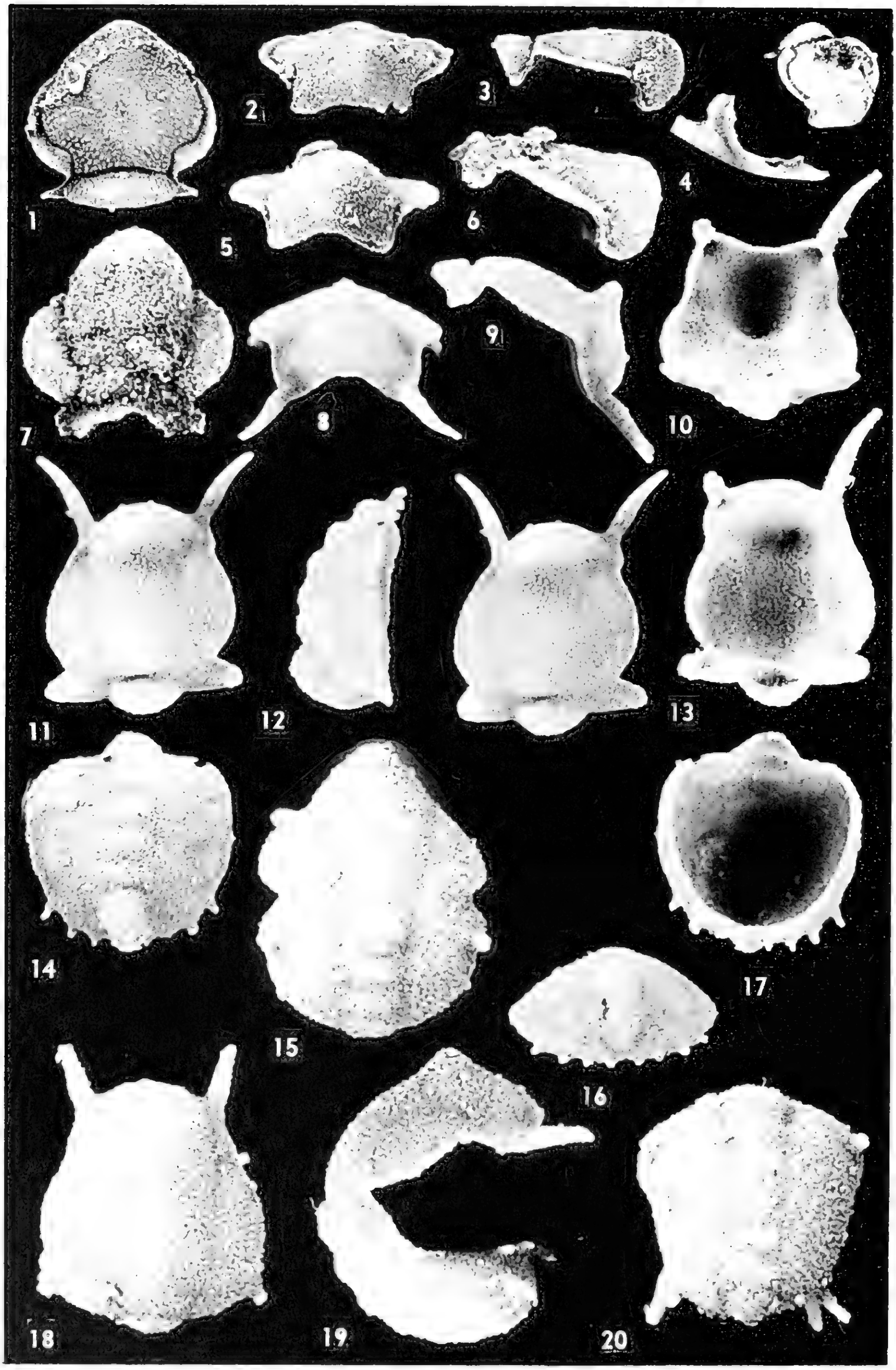

PLATE 10

PLATE 10

Remopleurides caphyroides n.sp.
Lower Edinburg formation

Figure	
1, 2, 3, 4	Small cranidium: dorsal, anterior, right lateral views, X 15, locality 2; oblique exterior view of same cranidium with free cheek of appropriate size from locality 3, X 9.
5, 6, 7	Meraspid cranidium: anterior, right lateral, dorsal views, X 30. Locality 6.
8, 9, 10, 11, 13	Degree 0 cranidium: anterior, right lateral, posteroventral views; dorsal stereograph, ventral view, X 30. Locality 2.
12, 14, 16, 17	Degree 0 transitory pygidium: right lateral, dorsal, posterior, ventral views, X 30. Locality 2.
15, 18, 19, 20	Protaspis: posterior, dorsal, right lateral, posteroventral views, X 30. Locality 4. Photographs by W. R. Evitt.

PLATE 11

Remopleurides caphyroides n.sp.
Lower Edinburg formation, locality 4

Figure	
1, 2, 3, 4	Protaspis: oblique exterior, ventral views; oblique exterior stereograph, anterior view, X 32.4. Photographs by W. R. Evitt.

Remopleurides caphyroides n.sp.?
Lower Edinburg formation

5	Small cranidium and free cheek: dorsal stereograph, X 15. Locality 3.
6, 7, 8	Meraspid cranidium: anterior, dorsal, right lateral views, X 30. Locality 4.
9, 10, 11	Degree 0 cranidium: dorsal, anterior, left lateral views, X 30. Locality 3.

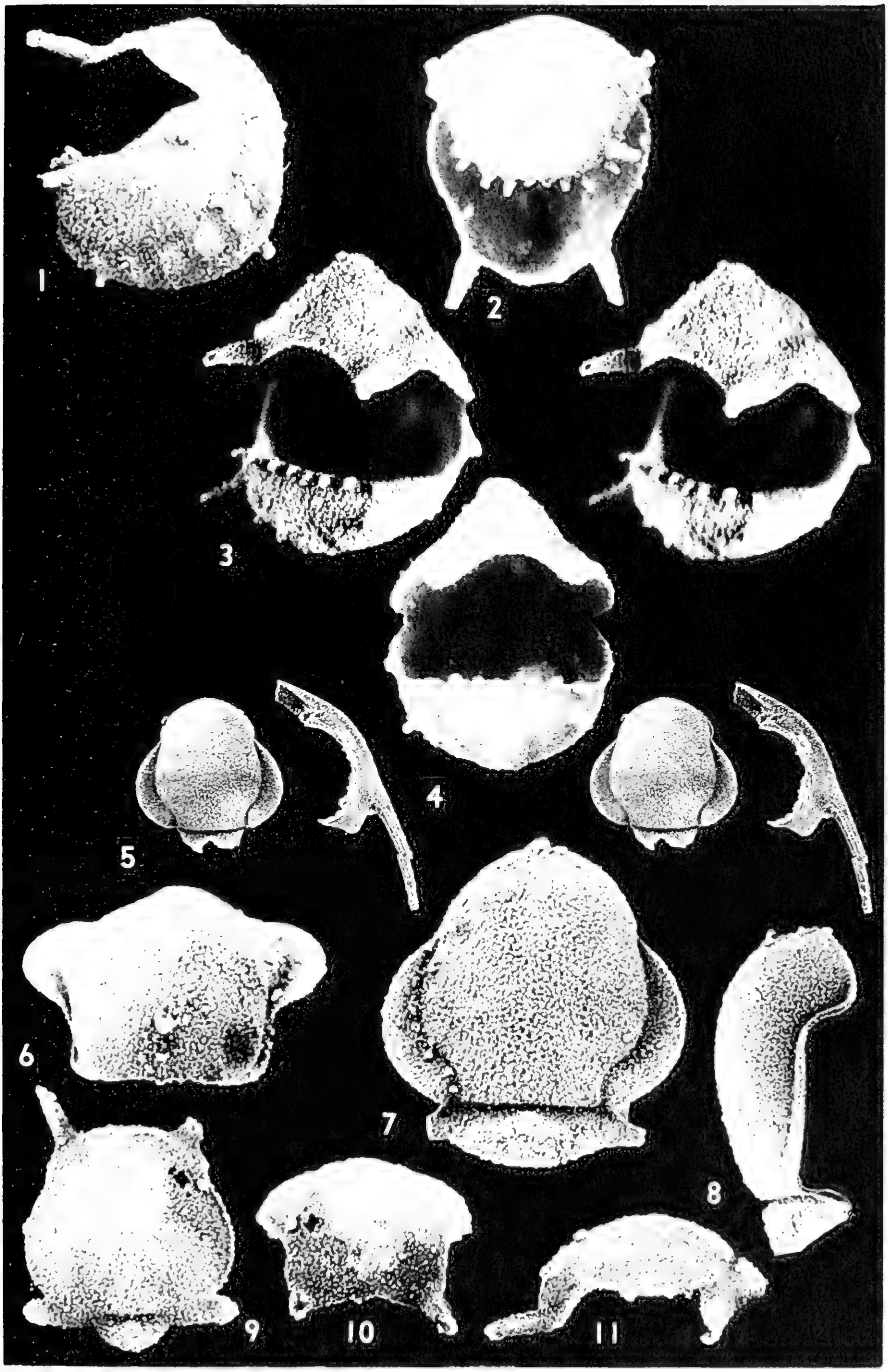

PLATE 11

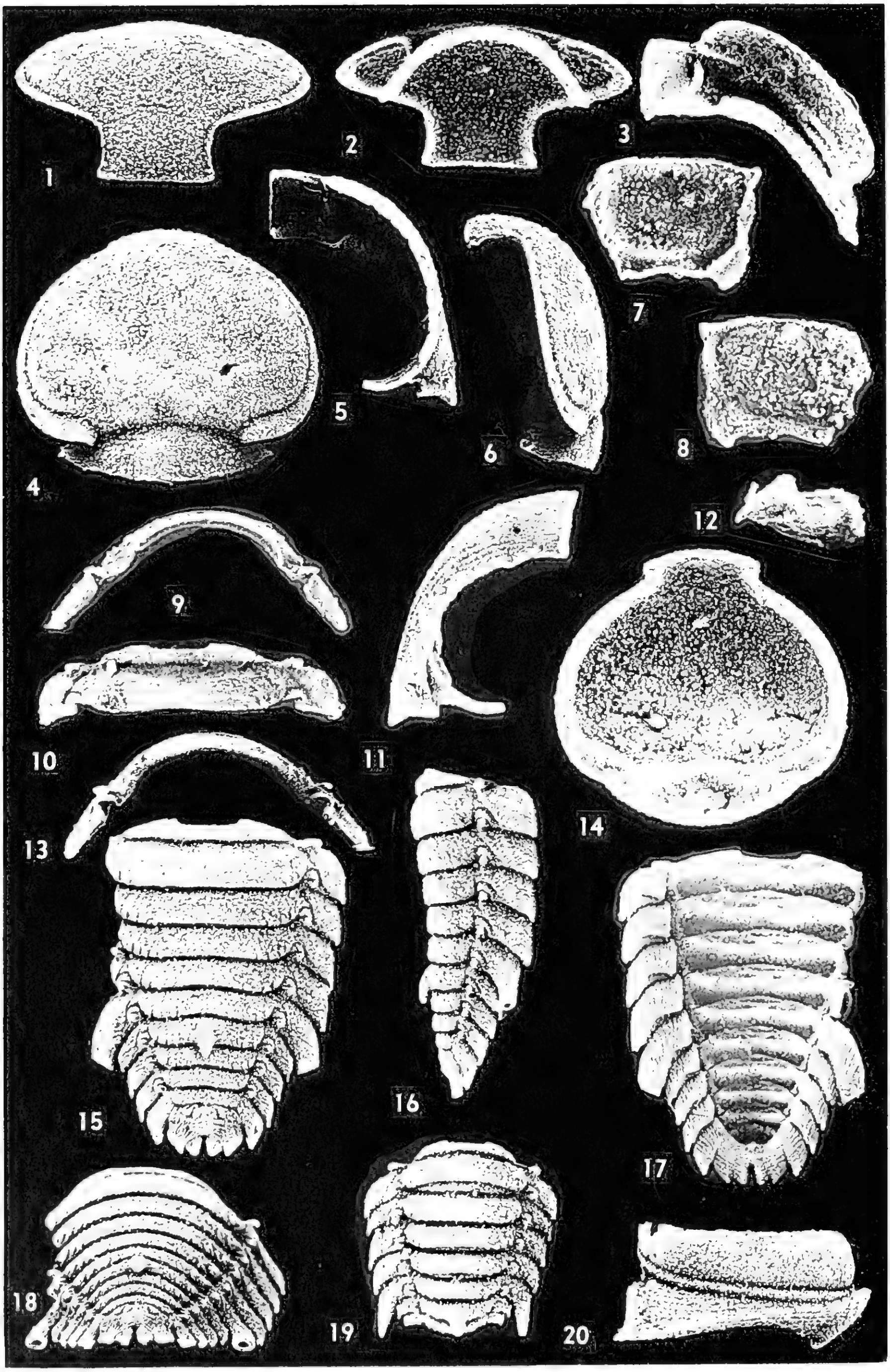

PLATE 12

PLATE 12

Remopleurides asperulus n. sp.
Upper Lincolnshire formation, locality 13

Figure	
1, 2, 4, 6, 14	Holotype cranidium: anterior, posterior, dorsal, left lateral, ventral views, X 6. USNM 137683.
3, 5, 11, 20	Paratype free cheek: oblique interior, dorsal, ventral, lateral views, X 6. USNM 137684a.
7, 8, 12	Paratype hypostome: interior, exterior, right lateral views, X 9. USNM 137684c.
9, 10, 13	Anterior thoracic segment: anterior, dorsal, posterior views, X 6.
15, 16, 17, 18	Paratype, nine thoracic segments and pygidium: dorsal, right lateral, ventral, posterior views, X 6. USNM 137684b.
19	Seven thoracic segments: exterior view, X 6.

PLATE 13

Remopleurides asperulus n.sp.
Lower Lincolnshire formation, locality 13

Figure	
1, 2, 3, 4, 10	Protaspis: dorsal, posterior, ventral, anterior, left lateral views, X 30.
5, 6, 7	Degree 0 cranidium: dorsal, right lateral, anterior views, X 30.
8, 9	Small hypostome: exterior, interior views, X 15.
11, 12, 13, 14, 15	Degree 0 transitory pygidium: dorsal, left lateral, anterior, posterior, ventral views, X 30.
16, 18, 19	Transitory pygidium: posterior, dorsal, ventral views, X 30.
17	Meraspid cranidium and free cheek: dorsal view, X 15.
20, 21, 22	Meraspid cranidium and free cheek: dorsal, right lateral, anterior views, X 9.
23	Small cranidium, dorsal view, X 8.
24, 25, 26	Small cranidium and free cheek: dorsal, right lateral, anterior views, X 6.
27, 31	Cranidium: anterior, dorsal views, X 6.
28, 29, 30	Cranidium and free cheek: dorsal, left lateral, anterior views, X 6.

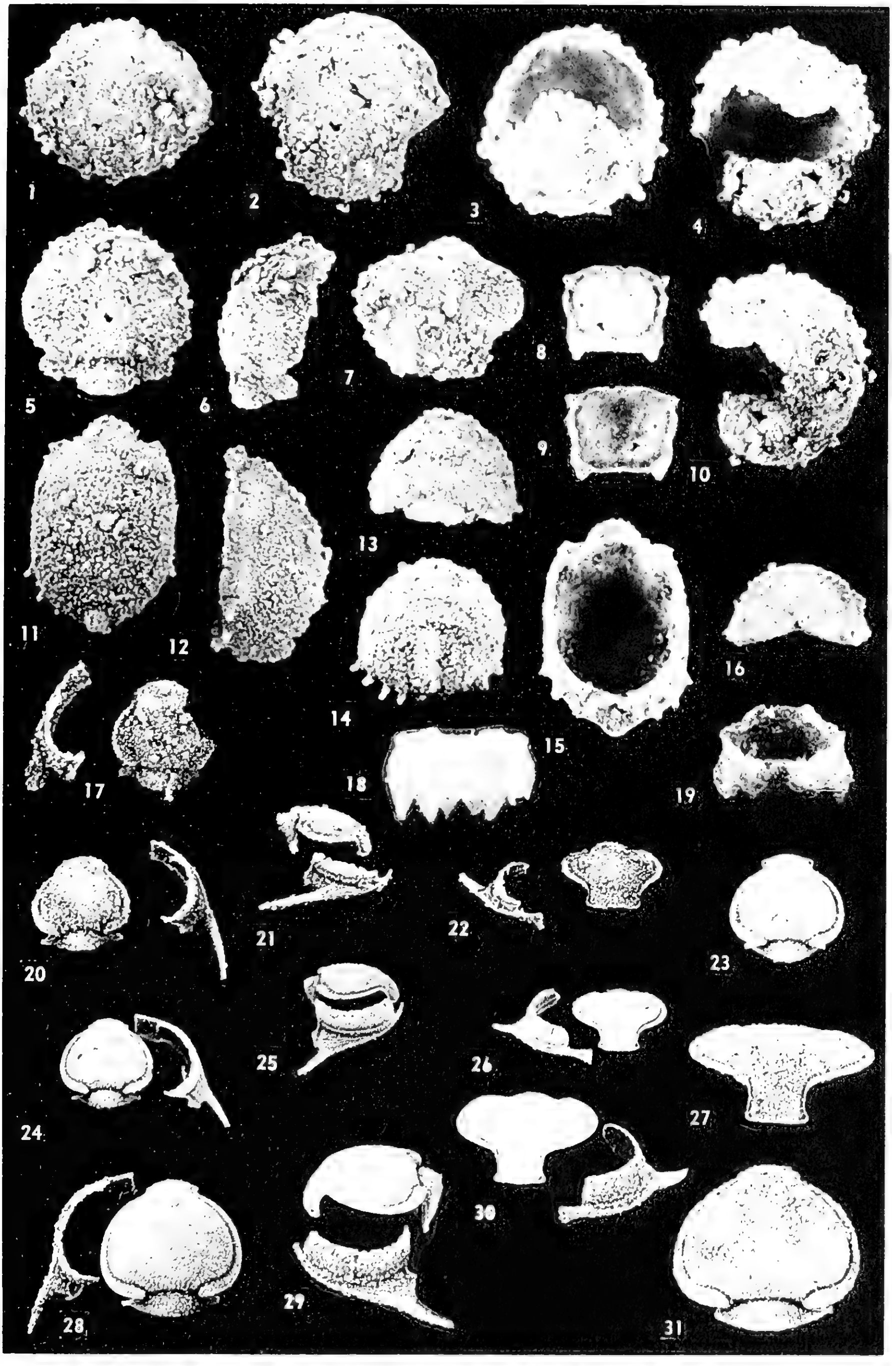
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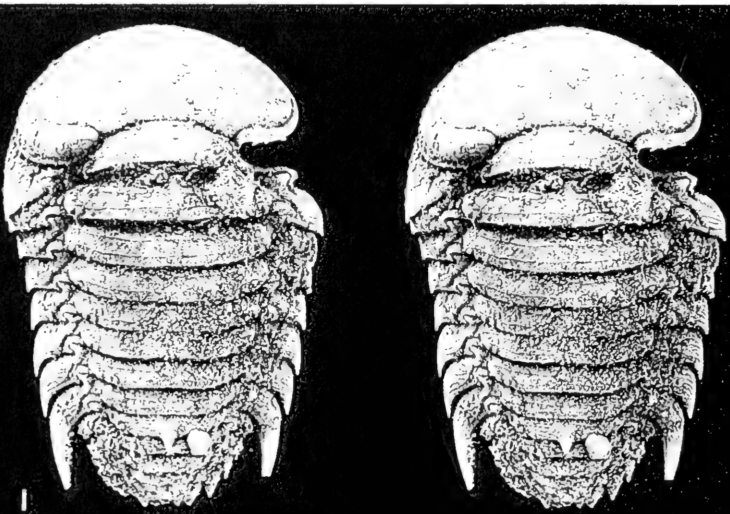
PLATE 13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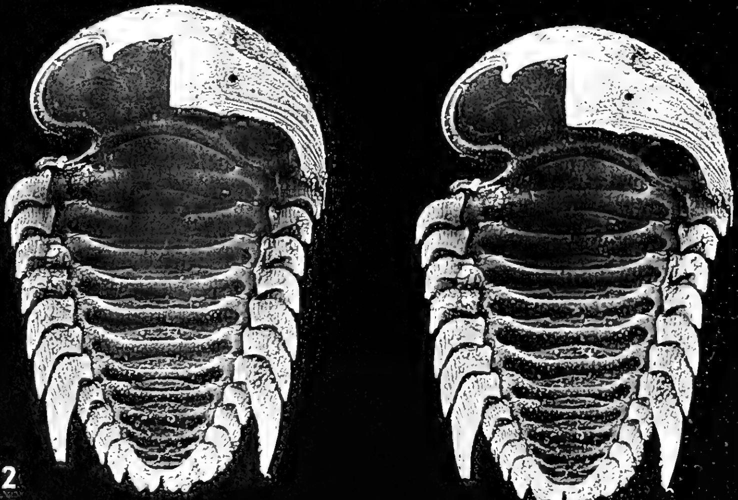
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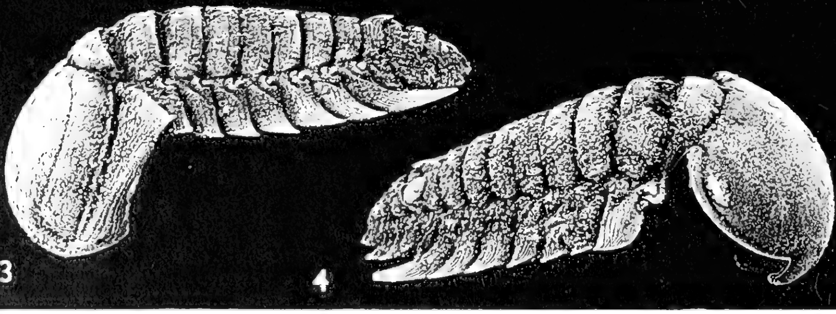
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PLATE 11

PLATE 14

Remopleurides eximius n.sp.
Lower Edinburg formation, locality 4

Figure	
1, 2, 3, 4	Holotype exoskeleton, lacking right free cheek and hypostome: exterior stereograph, interior stereograph, left lateral, right lateral views, X 3. USNM 137685.

PLATE 15

Remopleurides eximius n.sp.
Lower Edinburg formation

Figure	
1	Holotype exoskeleton: dorsal view of cephalon, X 3. Locality 4.
2, 3, 4, 5, 10	Paratype hypostome: exterior view, X 4½; oblique interior view, X 6; right lateral view, X 4½; anterior, interior views, X 6. USNM 137686a. Locality 3.
6, 7, 8, 11, 12	Complete thorax and pygidium: anterior, exterior, right lateral, posterior, oblique exterior views, X 3. Locality 3.
9, 13, 14	Paratype pygidium: dorsal, posterior, left lateral views, X 6. USNM 137686b. Locality 3.
15, 16	Posterior thoracic segment and pygidium: posterior, ventral views, X 6. Locality 3.
17, 18	Anterior part of doublure of right free cheek: ventral view showing pit in exterior; interior view showing cone extending inward from pit, X 15. Locality 3.

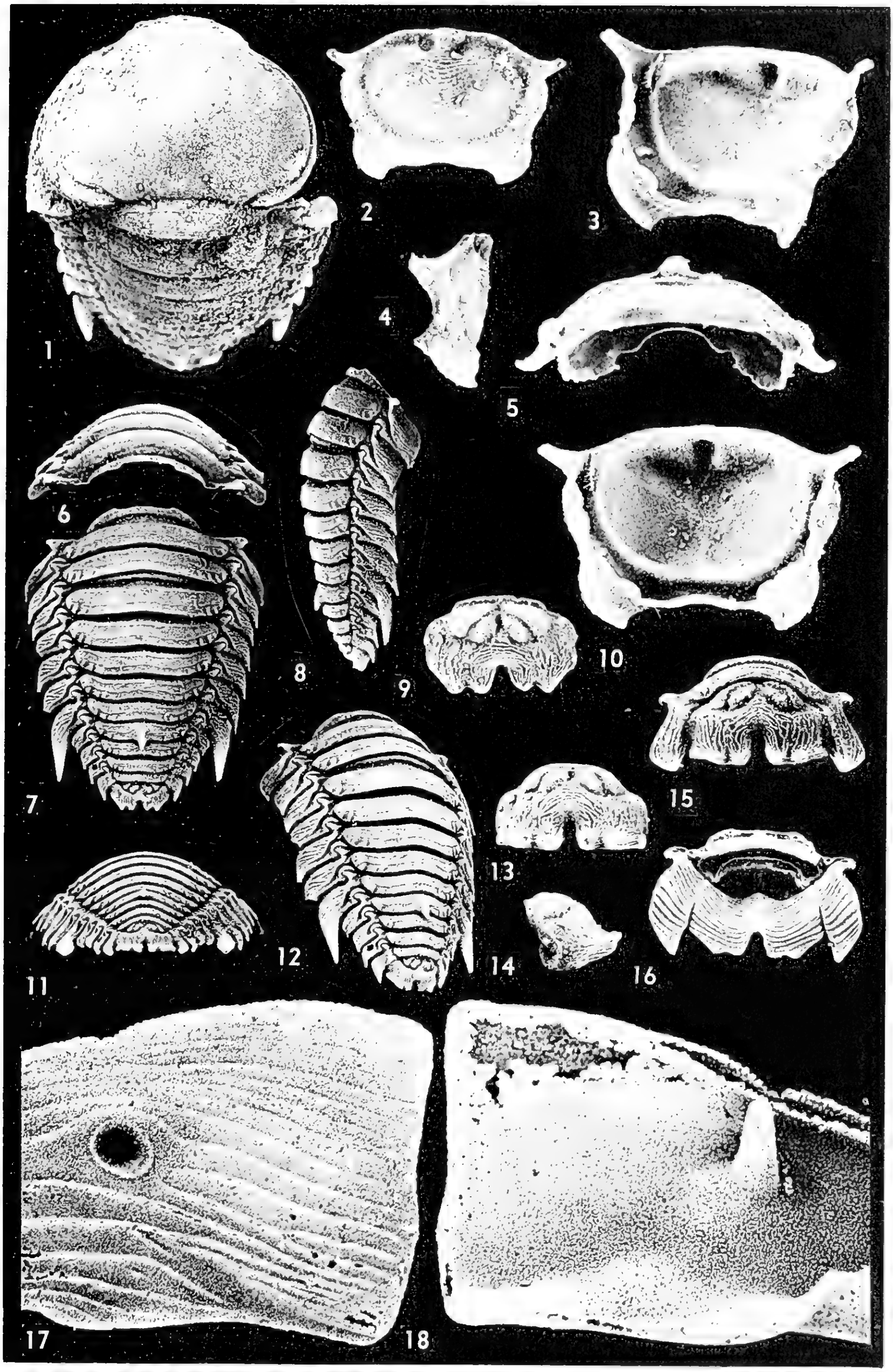


PLATE 15

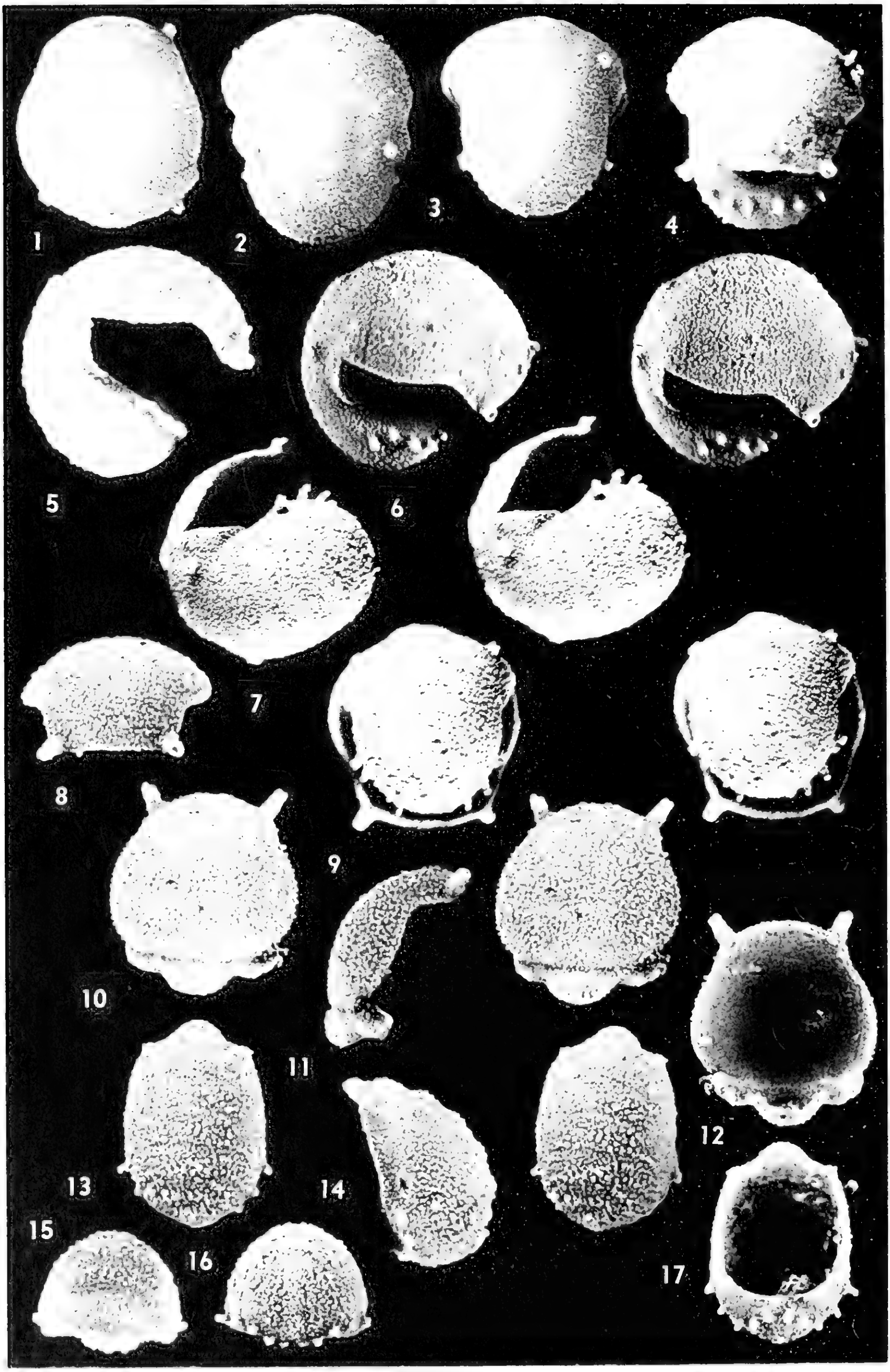


PLATE 16

PLATE 16

Remopleurides eximius n.sp.?
Lower Edinburg formation

Figure	
1, 2, 3, 6, 7, 9	Protaspis: dorsal, posterior, ventral views, X 32.4; anterolateral, posterolateral, ventral stereographs, X 33.2. Locality 4. Photographs by W. R. Evitt.
4, 5	Protaspis: anterior, right lateral views, X 32.4. Locality 4. Photographs by W. R. Evitt.
8, 10, 11, 12	Degree 0 cranidium: anterior view, dorsal stereograph, right lateral, ventral views, X 30. Locality 3.
13, 14, 15, 16, 17	Degree 0 transitory pygidium, dorsal stereograph, left lateral, anterior, posterior, ventral views, X 30. Locality 3.

PLATE 17

Remopleurides simulus n.sp.
Lower Edinburg formation

Figure	
1, 4, 5	Holotype cranidium, USNM 137687, and paratype free cheek, USNM 137688a: dorsal stereograph, oblique exterior, anterior views, X 4½. Locality 3.
2	Holotype cranidium: right lateral view, X 4½. Locality 3.
3, 10	Paratype free cheek: ventral, oblique interior views, X 4½. Locality 3.
6, 7, 8, 9	Cranidium: dorsal, left lateral, ventral, anterior views, X 4½. Locality 3.
11, 15, 16, 19	Five thoracic segments and pygidium: dorsal, ventral stereographs: right lateral, posterior views, X 4½. USNM 137688b. Locality 3.
12, 13, 14	Nine thoracic segments and pygidium: oblique exterior, posterolateral, exterior views, X 3. Locality 3.
17, 18, 21, 22, 23	Paratype hypostome: right lateral view, dorsal stereograph, posterior, interior, anterior views, X 6. USNM 137688c. Locality 3.
20	Small hypostome: exterior view, X 9. Locality 3.

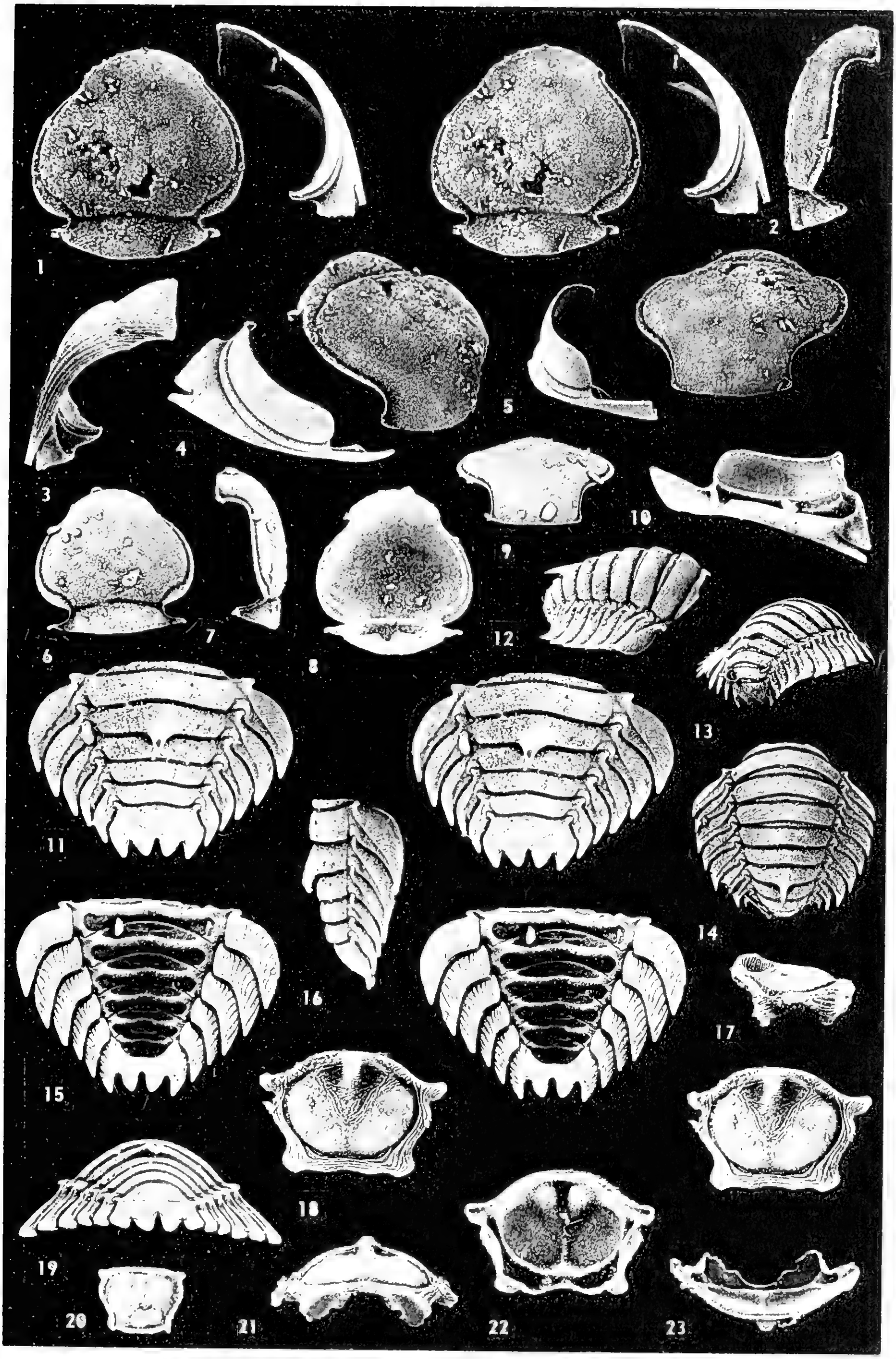


PLATE 17

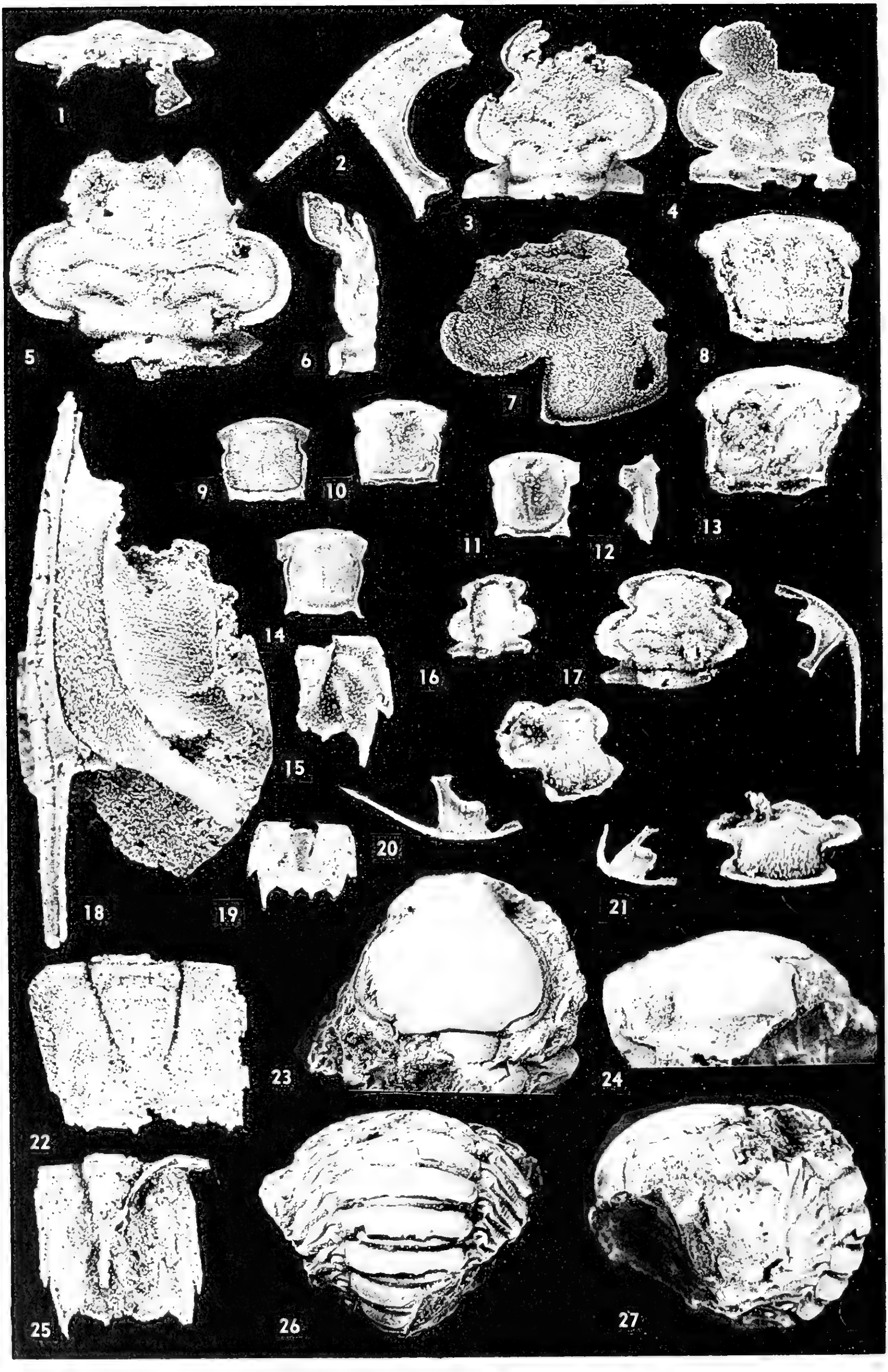


PLATE 18

PLATE 18

Robergia major Raymond, 1920
Lower Edinburg formation (Liberty Hall facies)

Figure	
1, 3, 6	Cranidium: anterior, dorsal, left lateral views, X 6. Locality 14.
2	Free cheek: exterior view, X 6. Locality 14.
4	Incomplete cranidium: interior view, X 6. Locality 16.
5	Incomplete cranidium: exterior view, X 6. Locality 14.
7	Incomplete cranidium: anterolateral view showing glabellar tongue, narrow anterior area of fixed cheek and narrow preglabellar field, X 6. Locality 14.
8, 13	Hypostome: exterior, interior views, X 6. Locality 14.
9, 10	Hypostome: exterior, interior views, X 6. Locality 14.
11, 12, 14	Hypostome: interior, right lateral, exterior views, X 6. Locality 16.
15, 19	Incomplete pygidium: dorsal view after specimen was broken, X 9, ventral view, X 6. Locality 16.
16	Meraspid cranidium: exterior view, X 9. Locality 14.
17, 20, 21	Cranidium and free cheek: dorsal, anterolateral, anterior views, X 9. Locality 14.
18	Incomplete free cheek: oblique interior view showing eye facets, X 15. Locality 14.
22	Pygidium: exterior view, X 6. Locality 14.
25	Pygidium: exterior view, X 6. Locality 14.

Remopleurides rugicostatus Raymond, 1925
Ridley Limestone, Murfreesboro, Tennessee

23, 24, 26, 27	Incomplete enrolled exoskeleton: dorsal, anterior views of cranidium, posterior, left lateral views of exoskeleton, X 4. MCZ 1611.

PLATE 19

Remopleuridid gen. et sp. ind.
Lower Edinburg formation

Figure	
1, 2	Degree 0 cranidium and free cheek: anterolateral and dorsal views, X 30. USNM 137689a. Locality 3.
3, 4	Degree 0 cranidium: dorsal, anterolateral views, X 30. USNM 137689b. Locality 4.
5	Meraspid cranidium and free cheek: dorsal view, X 30. USNM 137689c. Locality 4.
6, 10	Free cheek: dorsal, ventral views, X 9. Locality 3.
7	Meraspid cranidium and free cheek: dorsal view, X 30. USNM 137689d. Locality 4.
8	Meraspid cranidium and free cheek: dorsal stereograph, X 15. USNM 137689e. Locality 3.
9	Cranidium: dorsal view, X 15. USNM 137689f. Locality 4.

Remopleurides simulus n.sp.
Lower Edinburg formation, locality 3

11, 12	Paratype free cheek: oblique exterior view showing eye surface and external rim; oblique interior view, showing cone extending inward from pit in doublure, X 15.

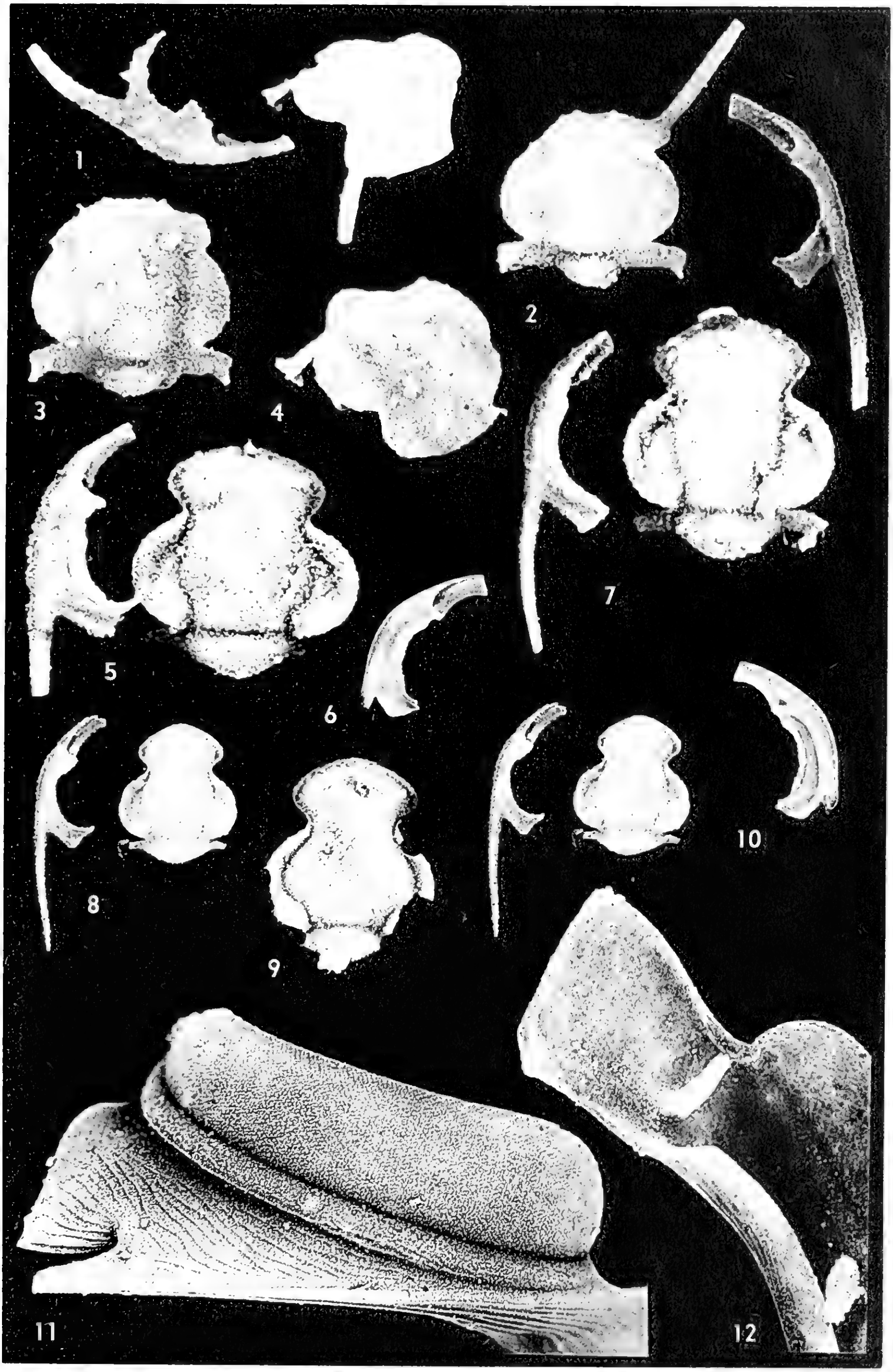


PLATE 19

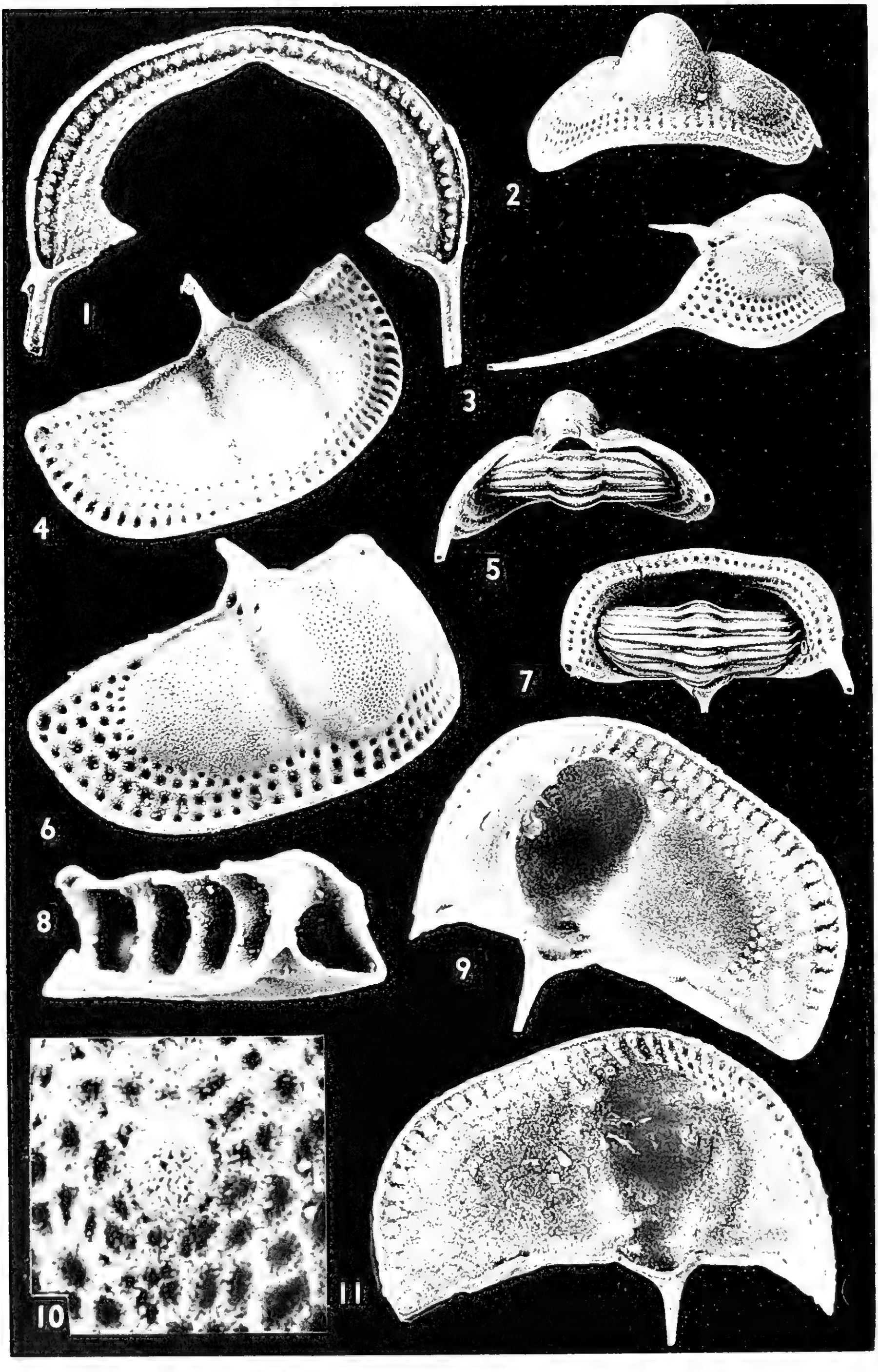


PLATE 20

PLATE 20

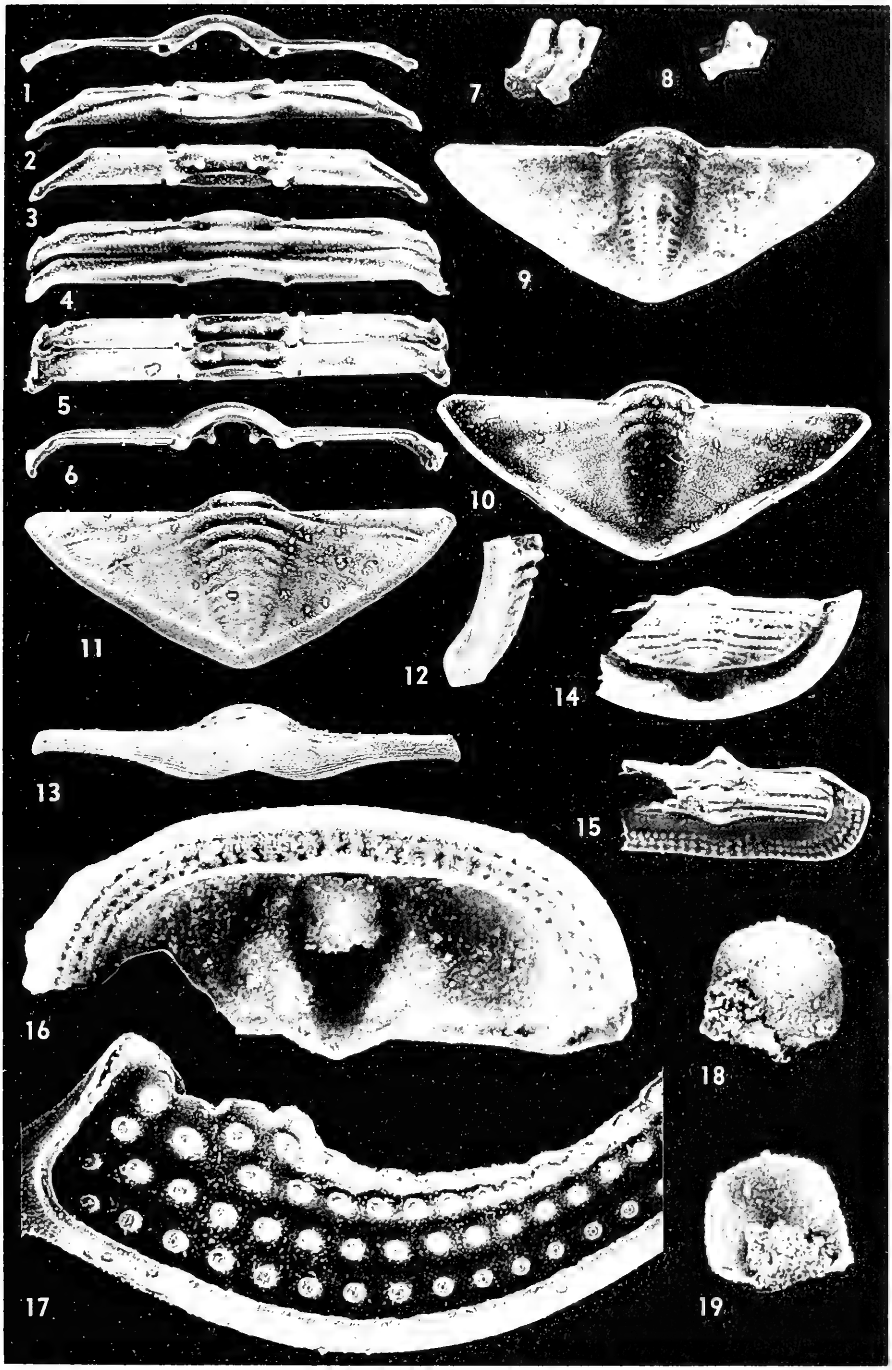
Cryptolithus tesselatus Green, 1832.
Lower Martinsburg shale

Figure	
1	Lower lamella of fringe: interior view, X 4½. Locality 9.
2, 3	Cephalon: anterior, right lateral views, X 3. Locality 12.
4	Cranidium: oblique exterior view, X 4½. Locality 9.
5, 7	Enrolled exoskeleton: posterior, ventral views, X 3. Locality 12.
6	Cranidium: oblique exterior view, X 6. Locality 10.
8	Fragment of external portion of fringe, viewed from broken edge which runs along girder, showing form of opposing pits, X 15. Locality 9.
9, 11	Cranidium: oblique interior views, showing muscle areas and flat bases of pits with central opening, X 4½. Locality 9.
10	Median area of glabella of original of figure 6, showing median tubercle and network of raised ridges, X 50. Locality 10.

PLATE 21

Cryptolithus tesselatus Green, 1832
Lower Martinsburg shale

Figure	
1, 2, 3, 8	Anterior thoracic segment: anterior, dorsal, ventral, right lateral views, X 6. Locality 10.
4, 5, 6, 7	Two articulated segments from the median part of the thorax: dorsal, ventral, posterior, right lateral views, X 6. Locality 10.
9, 10, 11, 12, 13	Pygidium: ventral (photographed under alcohol), ventral (coated), dorsal, left lateral, posterior views, X 6. Locality 10.
14, 15	Incomplete enrolled exoskeleton of degree 3: ventral, posterior views, X 12. Locality 9.
16	Incomplete cephalon: ventral view showing hypostome approximately in position, X 30. Locality 9.
17	Part of right side of lower lamella of fringe: interior view showing flat bases of pits and tiny median openings, X 9. Locality 10.
18, 19	Hypostome: exterior, interior views, X 30. Locality 10.



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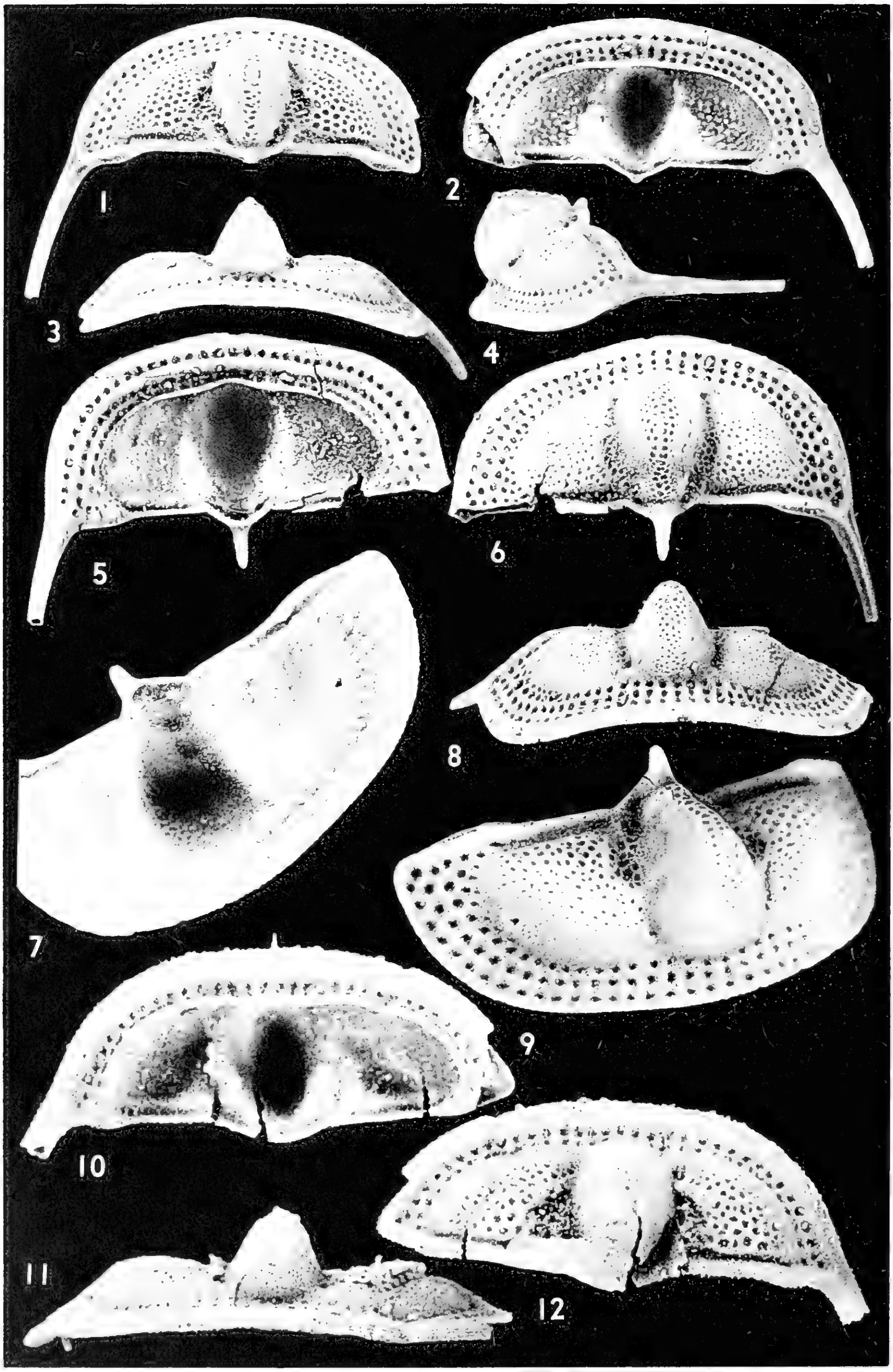


PLATE 22

PLATE 22

Cryptolithus tesselatus Green, 1832
Lower Martinsburg shale, locality 10

Figure	
1, 2, 3, 4	Small cephalon: dorsal, ventral, anterior, left lateral views, X 15.
5, 6, 8	Cephalon: ventral, dorsal, anterior views, X 9.
7, 9	Cranidium: oblique interior (showing dark muscle areas), oblique exterior views, X 15.
10, 11, 12	Meraspid cephalon: ventral, anterior, dorsal views, X 30.

PLATE 23

Cryptolithus tesselatus Green, 1832
Lower Martinsburg shale

Figure	
1, 2, 3, 4	Enrolled degree 1 exoskeleton, lacking lower lamella of the fringe: anterior, right lateral, ventral, dorsal views, X 30. Locality 9.
5, 7	Degree 1? cephalon: oblique exterior, ventral views, X 30. Locality 9.
6, 8, 9, 10	Enrolled degree 0 exoskeleton lacking lower lamella of fringe: dorsal, ventral, anterior, posterior views, X 30. Locality 9.
11, 12, 13, 15	Protaspis, lacking lower lamella of fringe: anterolateral and posterolateral stereographs, left lateral, dorsal views, X 45. Locality 10. Photographed by W. R. Evitt.
14, 16	Protaspis, lacking lower lamella of fringe: posterior, ventral views, X 50. Locality 10.
17, 18	Transitory pygidium: dorsal, posterior views, X 30. Locality 10.
19, 21, 23	Pygidium: dorsal, ventral, posterior views, X 20. Locality 10.
20, 22	Pygidium: dorsal, posterior views, X 15. Locality 10.

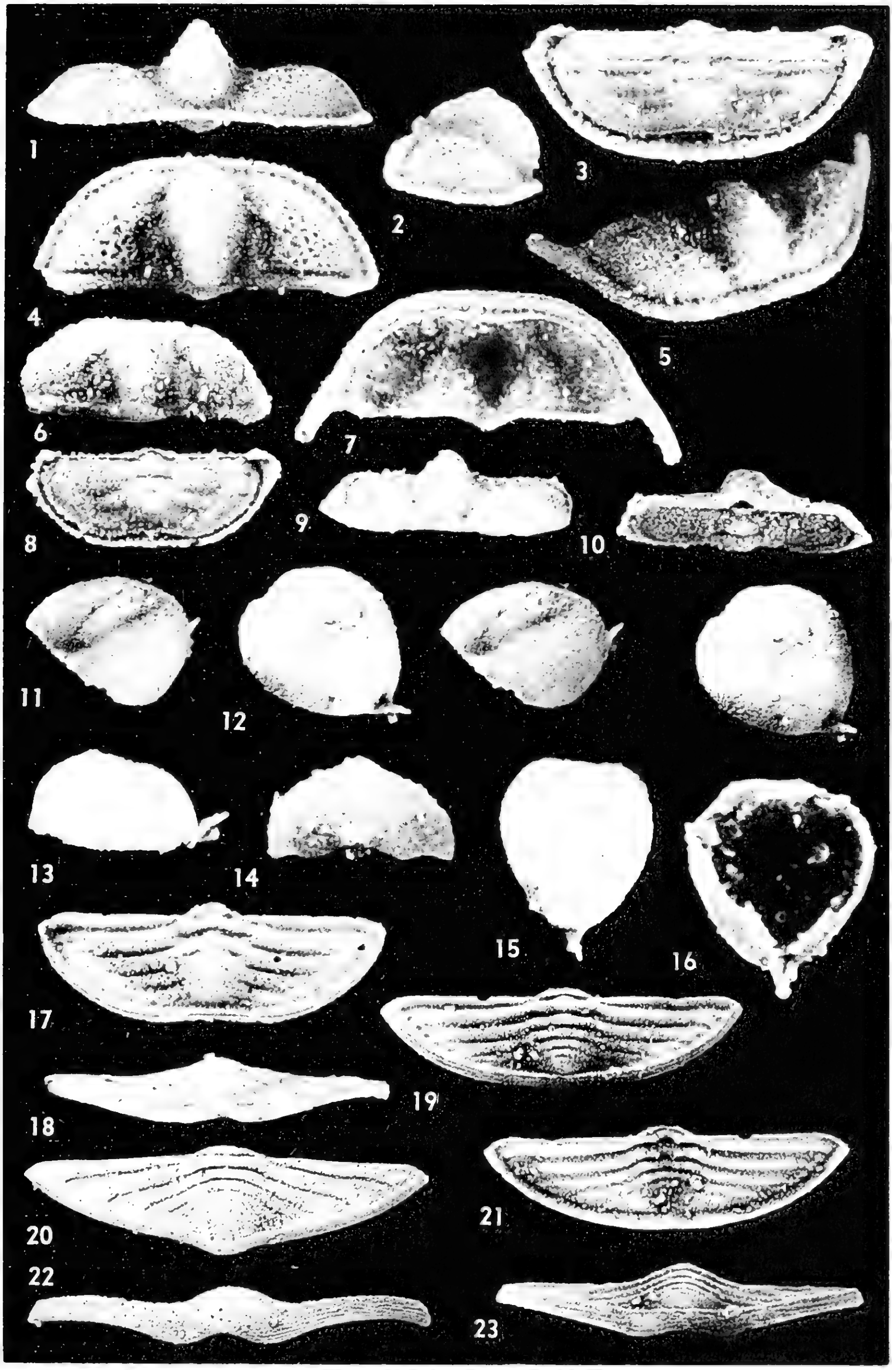


PLATE 23

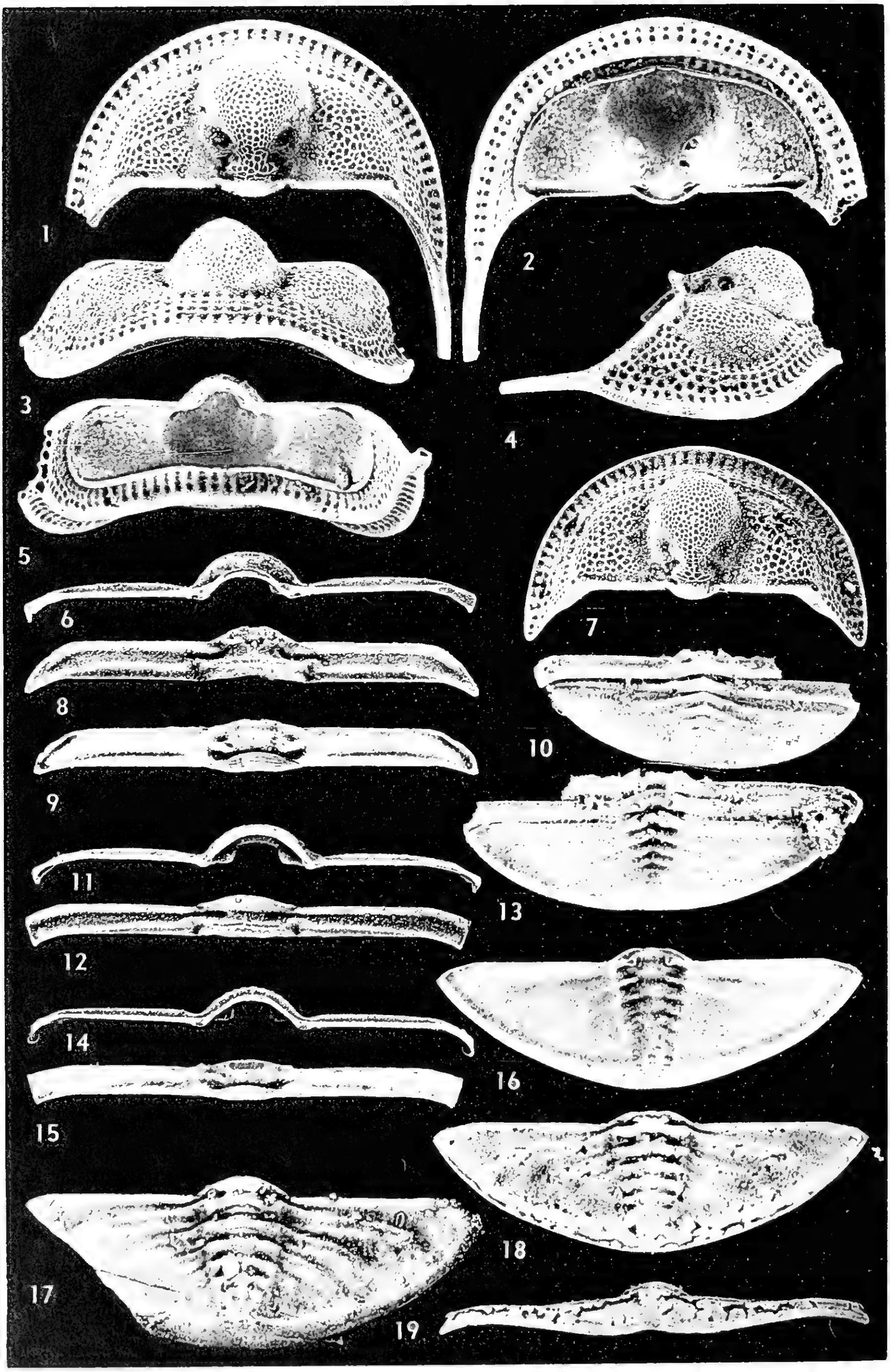


PLATE 24

PLATE 24

Tretaspis sagenosus n.sp.
Lower Edinburg formation

Figure	
1, 2, 3, 4, 5	Holotype cephalon: dorsal, ventral, anterior, right lateral, posterior views, X 4½. USNM 137690. Locality 16.
6, 8, 9, 11	Paratype anterior thoracic segment: anterior, dorsal, ventral, posterior views, X 6. USNM 137691a. Locality 16.
7	Cranidium: dorsal view, X 4½. Locality 16.
12, 14, 15	Paratype posterior thoracic segment: dorsal, anterior, ventral views, X 6. USNM 137691b. Locality 16.
10, 13	Pygidium and two thoracic segments: dorsal view, X 15, ventral view, X 20. Locality 2.
16, 18, 19	Paratype pygidium: ventral, dorsal, posterior views, X 6. USNM 137691c. Locality 16.
17	Incomplete pygidium: dorsal view, X 6. Locality 16.

PLATE 25

Tretaspis sagenosus n.sp.
Lower Edinburg formation, locality 16

Figure	
1	Oblique interior view of glabella and adjacent part of cheeks, showing muscle areas as darker spots adjacent to axial furrow; occipital ring at lower right, X 30.
2	Median part of glabella of original of Plate 24, figure 7, showing median tubercle and raised network of ridges, X 30.
3, 4	Portion of lower lamella of fringe: 3, interior view with external rim and sutural margin at lower left, and showing flat bases of pits with tiny central openings; 4, exterior view, external rim at top of figure, showing raised lines on girder and internal rim, X 30.
5, 6	Median portion of pygidium: external, internal views, showing appendifers and muscle areas as darker spots, X 15.

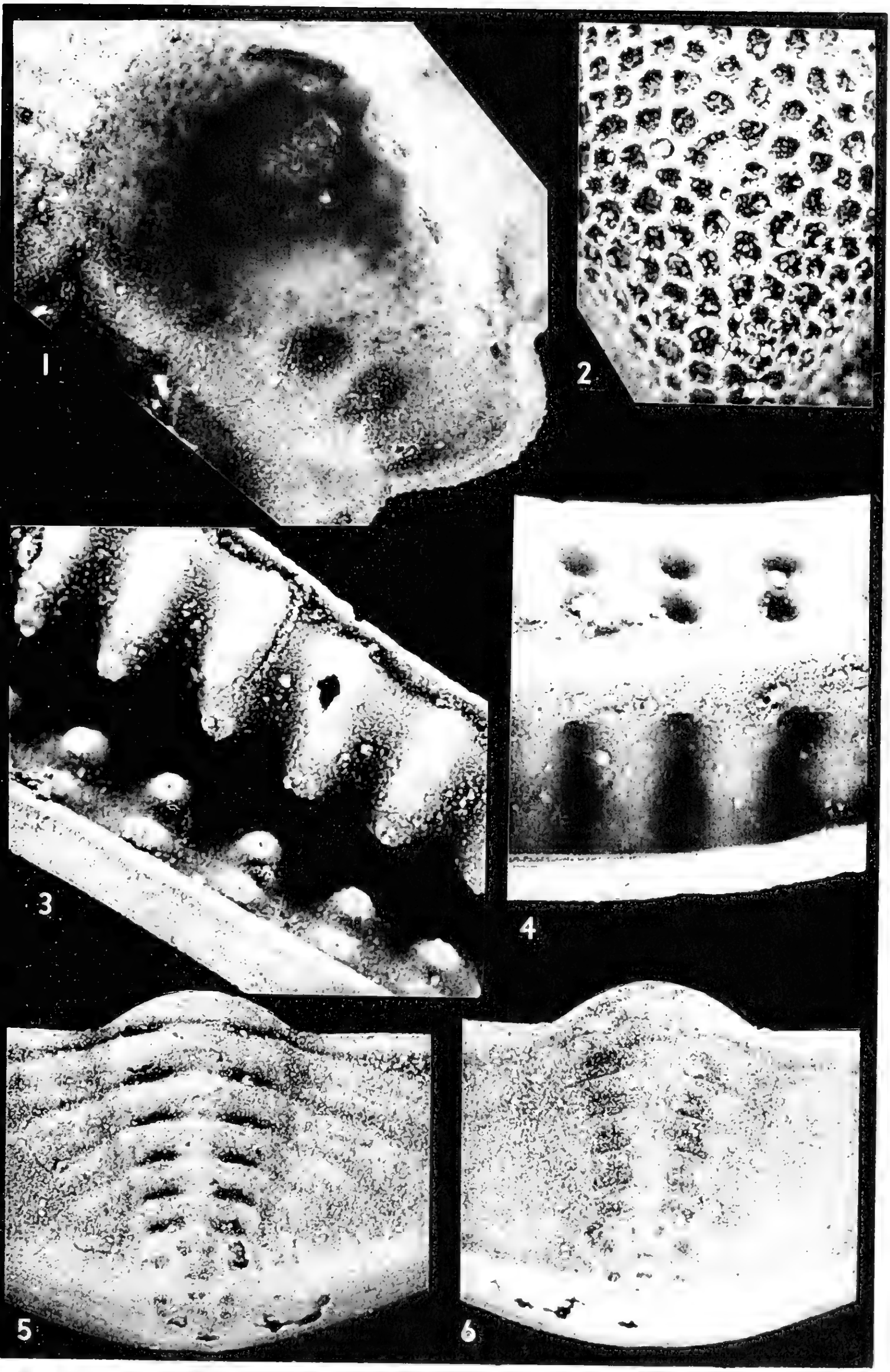


PLATE 25

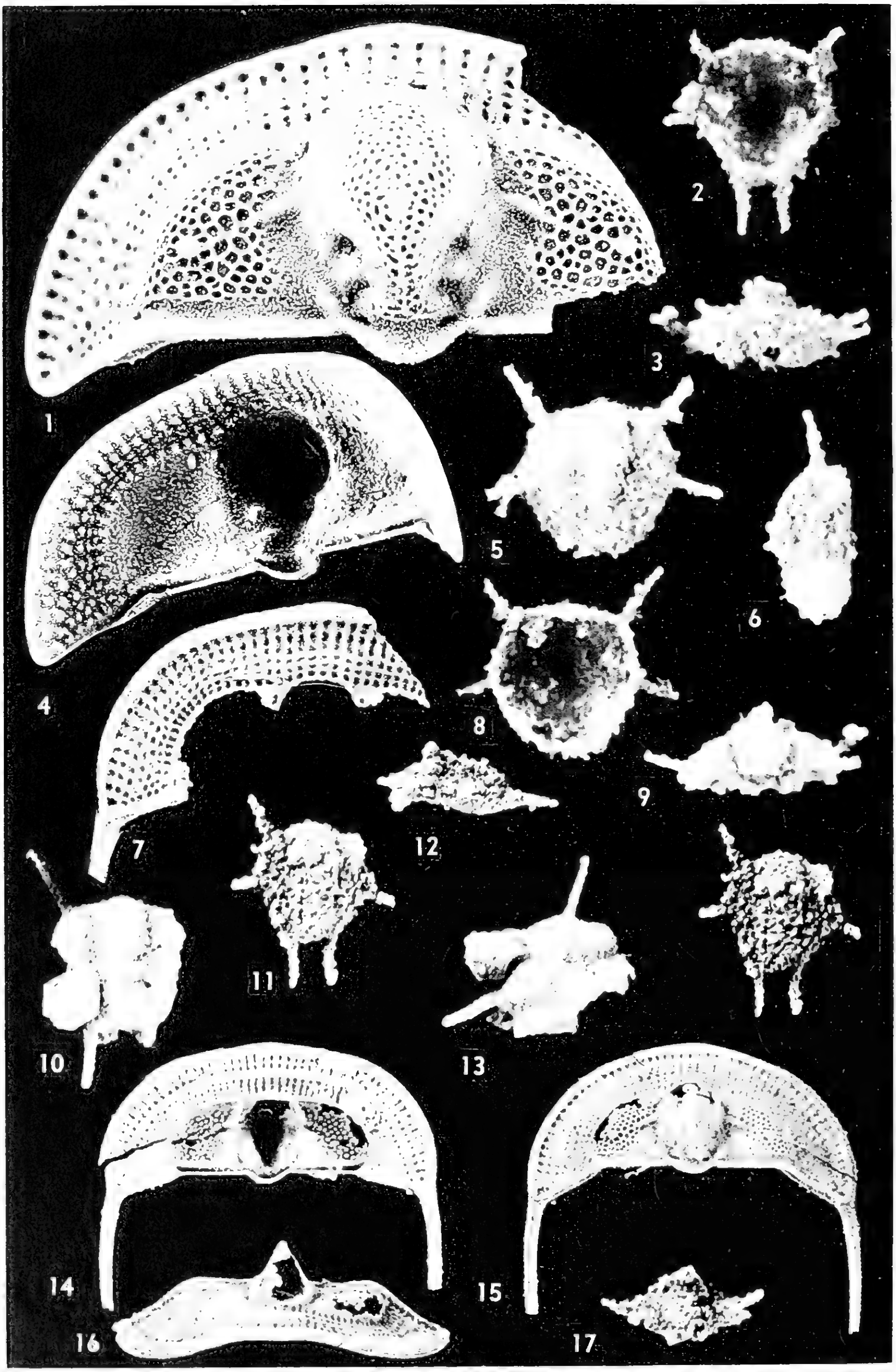


PLATE 26

PLATE 26

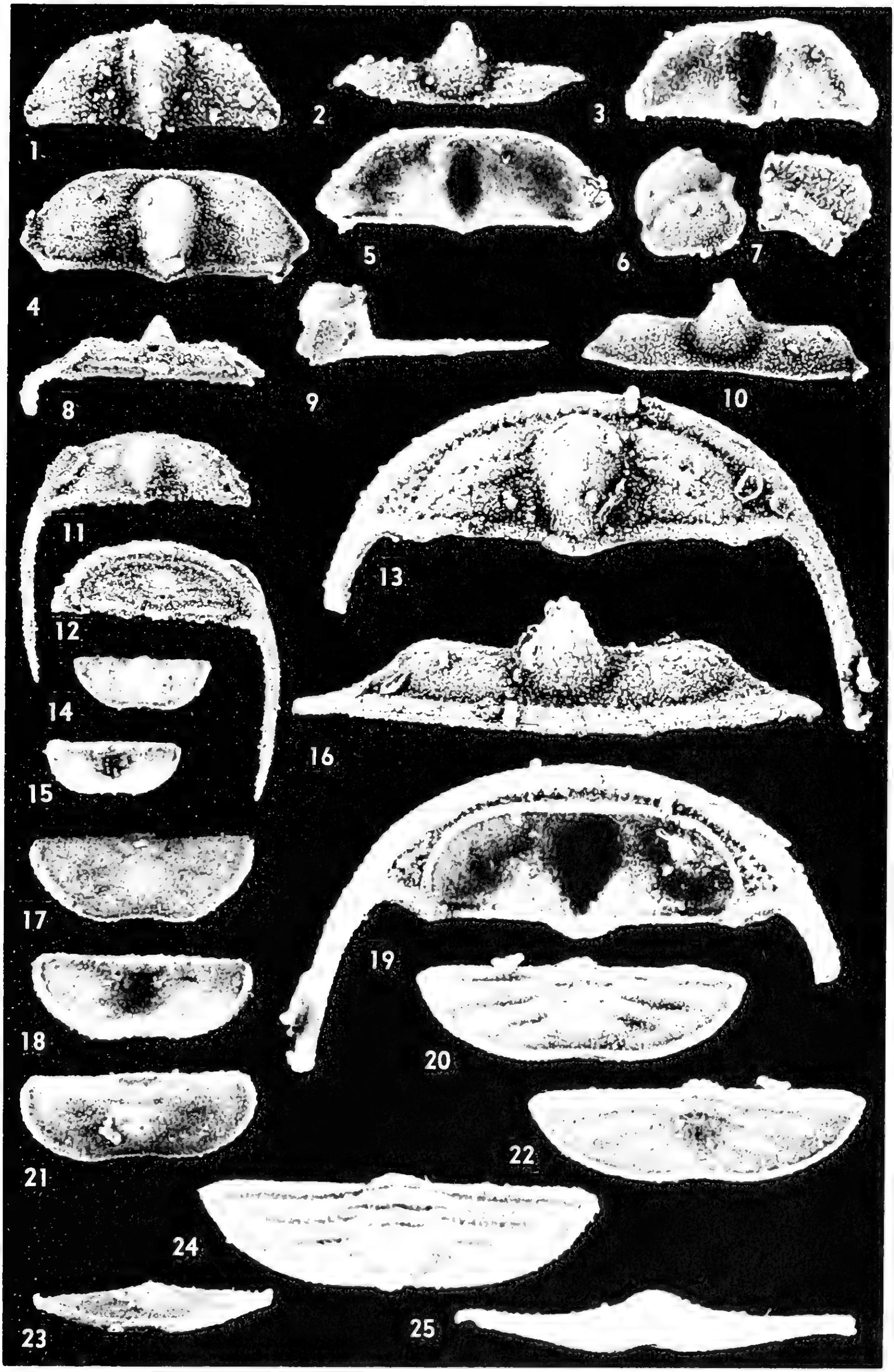
Tretaspis sagenosus n.sp.
Lower Edinburg formation

Figure	
1	Incomplete cranidium: exterior view, X 15. Locality 16.
2	Protaspis, lacking lower lamella of fringe: ventral view, X 50. Locality 4.
3, 5, 6, 8, 9	Protaspis, lacking lower lamella of fringe: posterior, dorsal, right lateral, ventral, anterior views, X 50. Locality 4.
4	Cranidium, original of Plate 24, figure 7: oblique interior view, X 6. Locality 16.
7	Part of fringe: exterior view, X 9. Locality 2.
10, 13	Incomplete protaspis, lacking lower lamella of fringe: dorsal, posterolateral views, X 45. Locality 4. Photographs by W. R. Evitt.
11, 12, 17	Protaspis, lacking lower lamella of fringe: dorsal stereograph, left lateral, anterior views, X 45. Locality 4. Photographs by W. R. Evitt.
14, 15, 16	Cephalon: interior, exterior, anterior views, showing three rows of pits external to girder, X 9. Locality 2.

PLATE 27

Tretaspis sagenosus n.sp.
Lower Edinburg formation

Figure	
1, 2, 3, 7	Degree 0 cranidium: dorsal, anterior, ventral, right lateral views, X 30. Locality 4.
4, 5, 6, 10	Degree 0? cranidium: dorsal, ventral, left lateral, anterior views, X 30. Locality 4.
8, 9, 11, 12	Degree 1 enrolled exoskeleton: posterior, left lateral, dorsal, ventral views, X 15. Locality 3.
13, 16, 19	Meraspid cephalon: dorsal, anterior, ventral views, X 30. Locality 4.
14, 15	Transitory pygidium: dorsal, ventral views, X 30. Locality 4.
17, 18	Transitory pygidium: dorsal, ventral views, X 30. Locality 4.
20, 22	Transitory pygidium: dorsal, ventral views, X 30. Locality 3.
21, 23	Transitory pygidium: dorsal, posterior views, X 30. Locality 3.
24, 25	Transitory pygidium: dorsal, posterior views, X 30. Locality 3.



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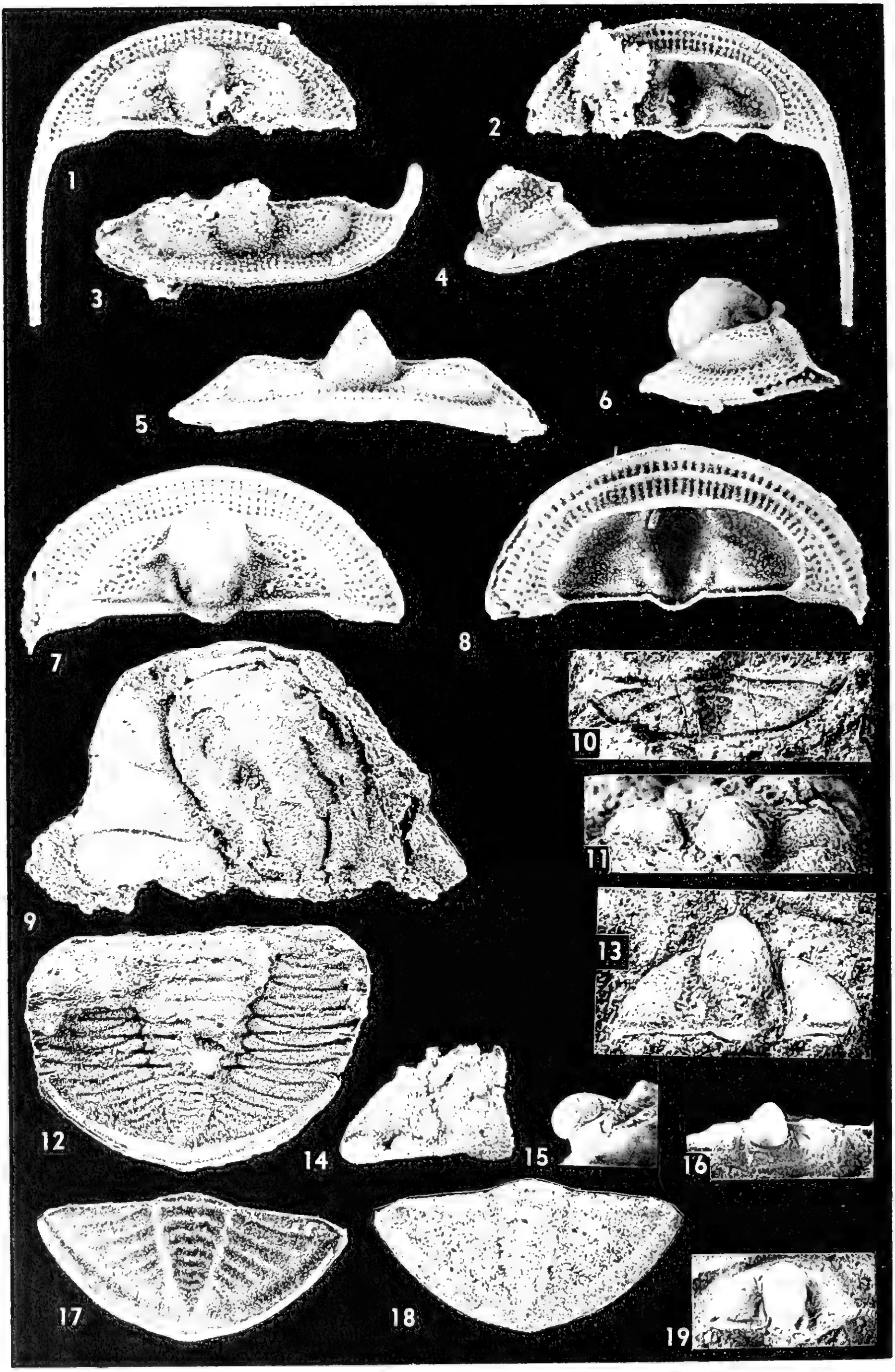

PLATE 28

PLATE 28

Tretaspis sagenosus n.sp.
Lower Edinburg formation

Figure	
1, 2, 3, 4	Incomplete cephalon: dorsal, ventral, anterior, left lateral views, X 15. Locality 3.
5, 6, 7, 8	Incomplete cephalon: anterior, left lateral, dorsal, ventral views, X 15. Locality 7.

Salteria americana Cooper, 1953
Lower Edinburg formation, locality 14

9	Incomplete cranidium: exterior view, X 6.
12	Thorax and pygidium: dorsal view, X 3.
14	Incomplete left half of cranidium: exterior view, X 6.
17, 18	Pygidium: ventral, dorsal views, X 6.

Ampyxina aldonensis (Reed, 1935)
Didymograptus superstes shale, Aldons, Girvan, Scotland

10	External mold of pygidium, X 4. Original of Reed, 1935, p. 7; HM A 1126.
11, 13	Internal mold of cranidium: anterior, dorsal views, X 4. Original of Reed, 1935, plate 1, figure 23; HM A 919.

Raymondella sp.
Upper six feet of Chambersburg limestone (Oranda formation),
Chambersburg, Penna.

15, 16, 19	Incomplete cranidium: left lateral, anterior, dorsal views, X 6. Original of Cooper, 1953, pp. 14, 15.

PLATE 29

Ampyx virginiensis Cooper, 1953
Lower Edinburg formation

Figure	
1, 2, 3, 4	Cranidium: left lateral, dorsal, oblique exterior, ventral views, X 6. Locality 3.
5, 6, 7, 8, 11	Cranidium and left free cheek: oblique exterior, anterior, ventral, left lateral, dorsal views, X 4½. Locality 2.
9, 12	Hypostome: exterior, left lateral views, X 15. Locality 2.
10, 13, 14, 15, 16	Hypostome: interior, anterior, posterior, left lateral, exterior views, X 6. Locality 2.

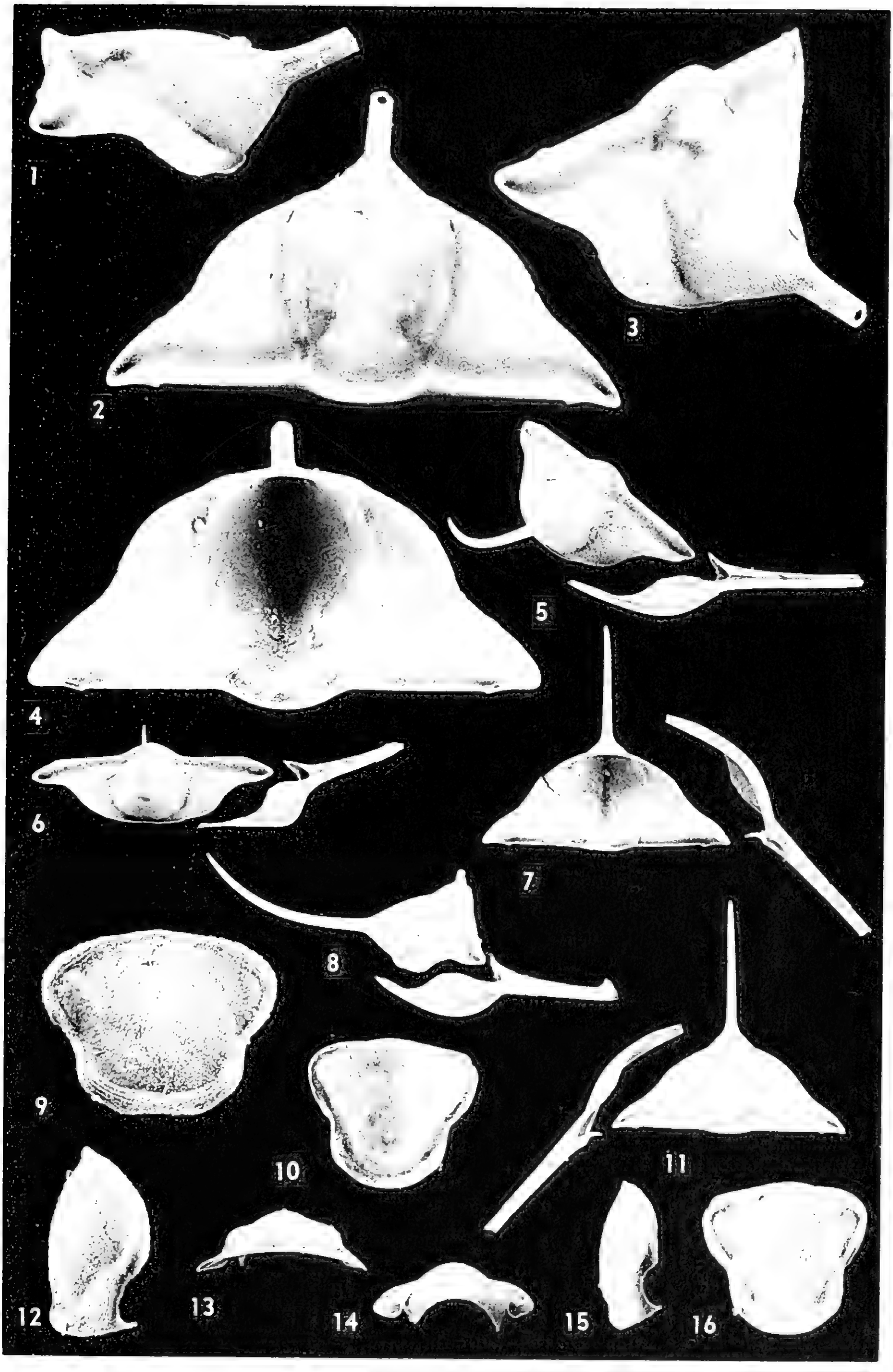

PLATE 29

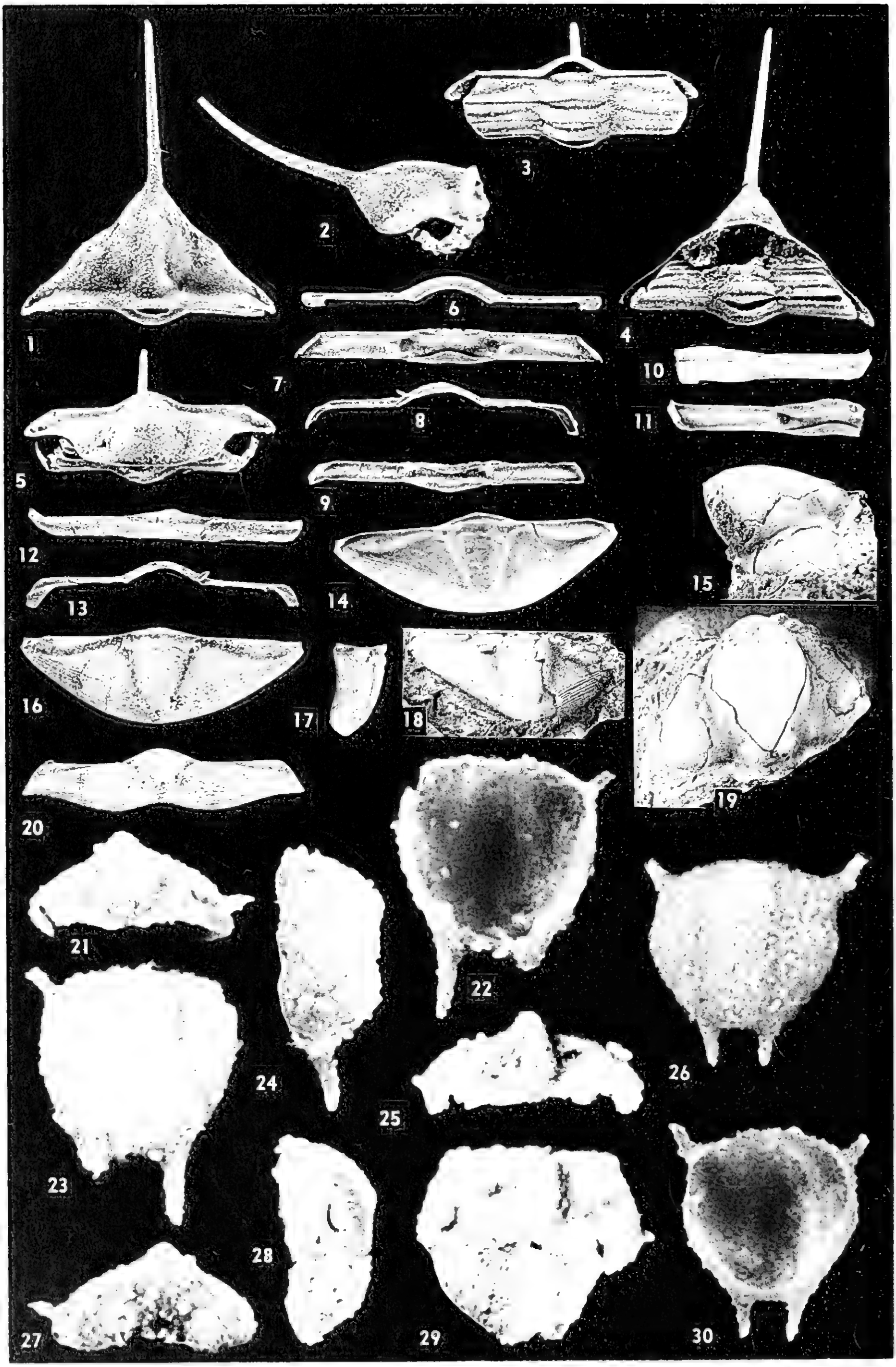
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PLATE 30

PLATE 30

Ampyx virginiensis Cooper, 1953
Lower Edinburg formation

Figure	
1, 2, 3, 4, 5	Cranidium and enrolled thorax: dorsal, left lateral, posterior, ventral, anterior views, X 6. Locality 6.
6, 7	Anterior thoracic segment: anterior, ventral views, X 4. Locality 2.
8, 9, 12, 13	Posterior thoracic segment: anterior, ventral (anterior edge facing downward in figure), dorsal, posterior views, X 4. Locality 2.
10, 11	Incomplete thoracic segment: dorsal, ventral views, X 4. Locality 2.
14, 16, 17, 20	Pygidium: ventral, dorsal, left lateral, posterior views. X 4. Locality 2.
21, 22, 23, 24, 27	Protaspis, lacking free cheeks: anterior, ventral, dorsal, left lateral, posterior views, X 50. Locality 3.
25, 28, 29	Protaspis, lacking free cheeks: anterior, left lateral, dorsal views, X 45. Locality 4. Photographs by W. R. Evitt.
26, 30	Protaspis, lacking free cheeks: dorsal, ventral views, X 50. Locality 3.

Ampyx camurus Raymond, 1925
Base of Edinburg formation (Liberty Hall facies), Lexington, Va.

15, 19	Lectotype (here selected) cranidium: left lateral, dorsal views, X 3. MCZ 1669. Original of Raymond, 1925, plate 2, figures 5, 6.
18	Paratype pygidium: dorsal view, X 3. MCZ 1668. Original of Raymond, 1925, plate 2, figure 7.

PLATE 31

Ampyx virginiensis Cooper, 1953
Lower Edinburg formation

Figure	
1, 2	Meraspid degree 0, lacking free cheeks: dorsal, ventral views, X 50. Locality 16.
3-5	Small cranidium: dorsal, left lateral, anterior views, X 25. Locality 4.
6, 10, 11	Cranidium and right free cheek: dorsal, right lateral, anterior views, X 15. Locality 2.
7, 8, 9	Small cranidium and left free cheek, doublure broken near midline: dorsal, anterior, left lateral views, X 20. Locality 4.
12, 14, 17	Cranidium: anterior, right lateral, dorsal views, X 9. Locality 2.
13, 15, 16	Cranidium: anterior, dorsal, right lateral views, X 9. Locality 2.
18, 19, 20	Cranidium and left free cheek: left lateral, dorsal, anterior views, X 9. Locality 2.
21, 22	Small pygidium: dorsal, ventral views, X 30. Locality 4.
23, 24	Small pygidium: dorsal, posterior views, X 15. Locality 3.
25, 28	Pygidium: dorsal, posterior views, X 15. Locality 3.
26, 29	Pygidium: dorsal, posterior views, X 15. Locality 3.
27, 30	Small pygidium: dorsal, posterior views, X 15. Locality 3.
31, 32	Pygidium: dorsal, posterior views, X 15. Locality 2.

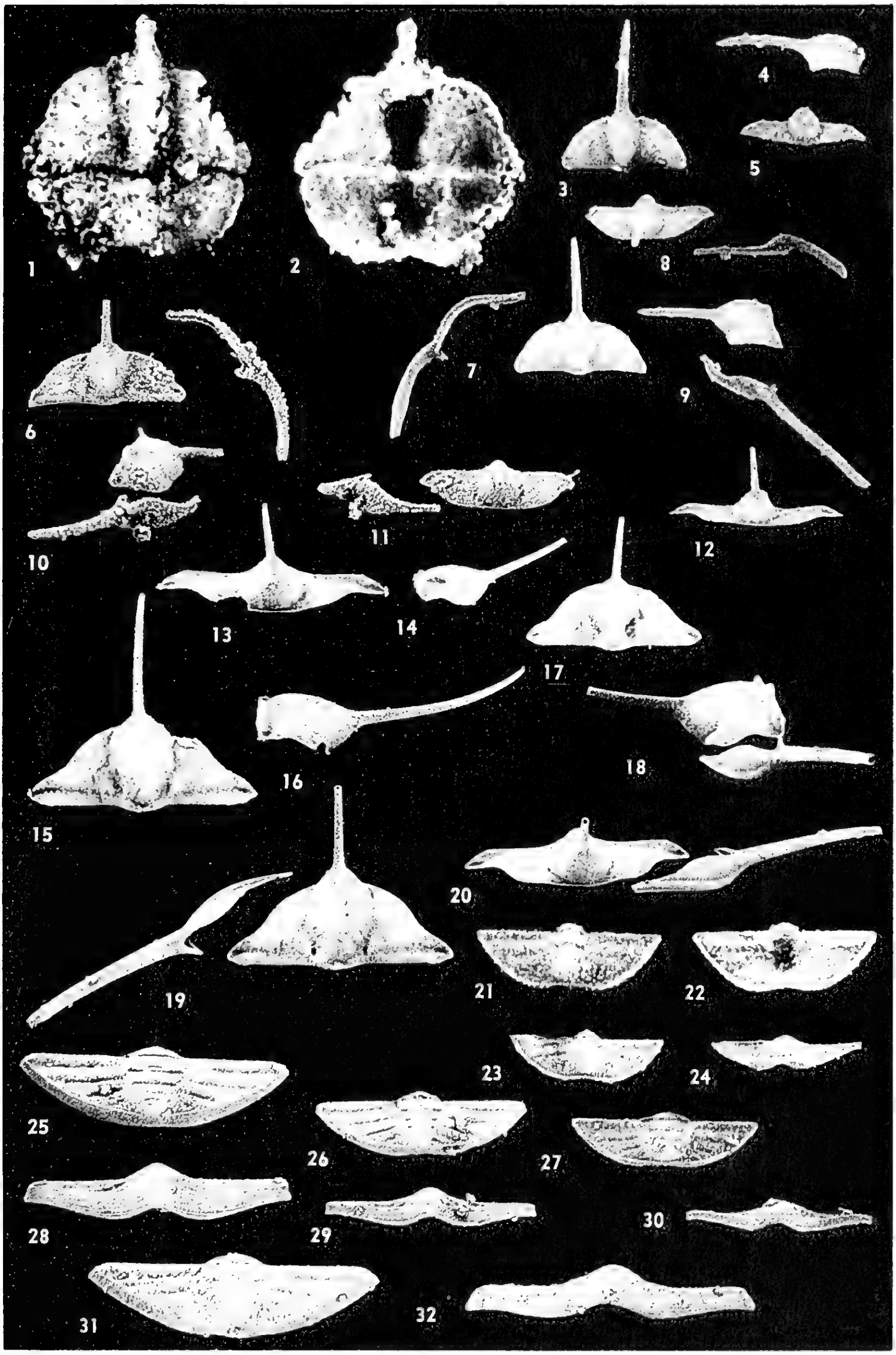
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PLATE 31

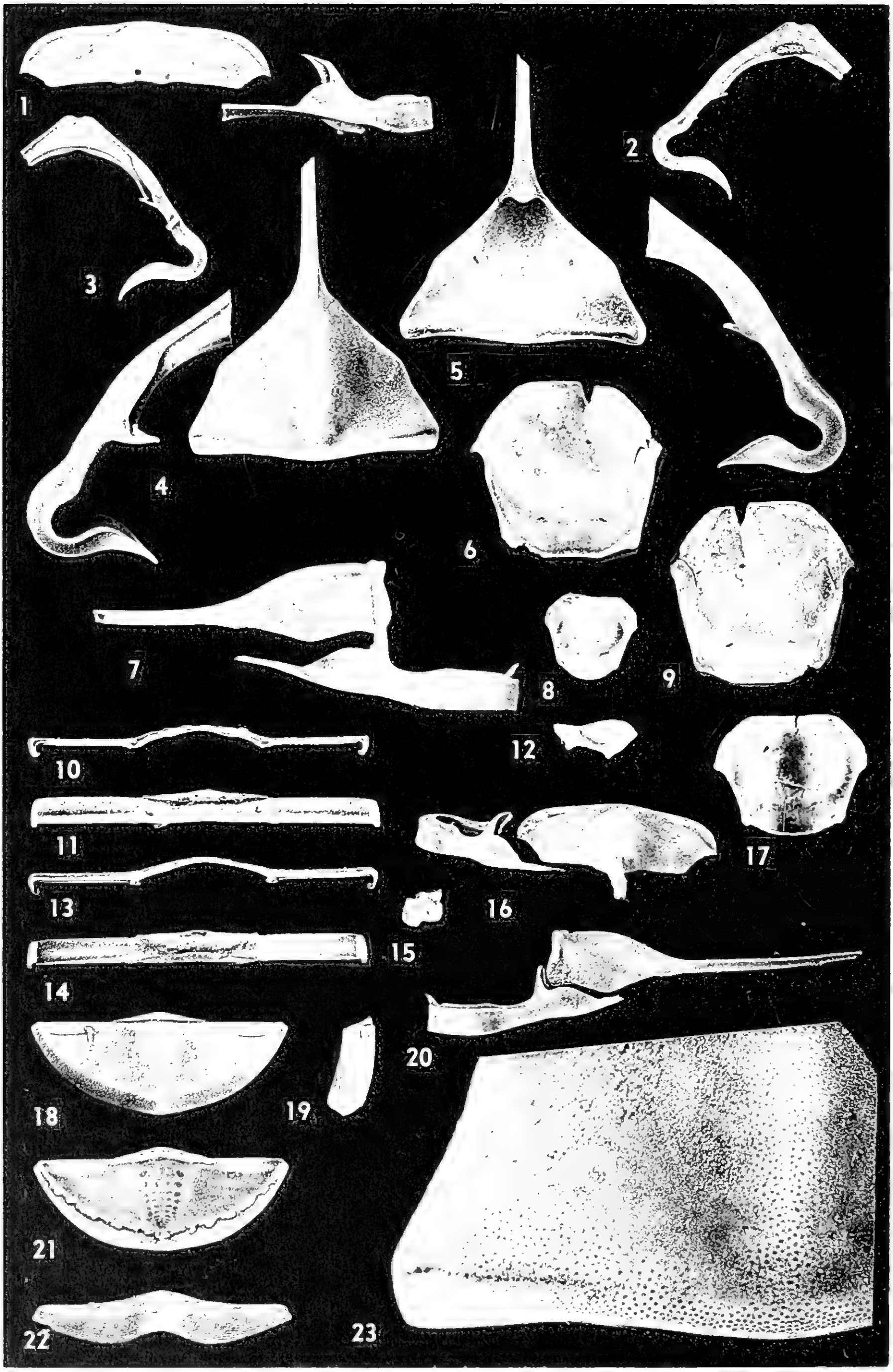

PLATE 32

PLATE 32

Lonchodomas carinatus Cooper, 1953
Lower Edinburg formation

Figure	
1, 4, 5, 7	Cranidium and incomplete left free cheek: anterior, dorsal, ventral, left lateral views, X 3. Locality 5.
2, 3	Right free cheek and anteromedian portion of doublure: ventral, dorsal views, X 3. Locality 2.
6, 9	Hypostome: interior, exterior views, X 3. Locality 2.
8, 12, 17	Hypostome: exterior, left lateral views, X 6, interior view, X 9. Locality 2.
10, 11, 13-15	Thoracic segment: anterior, dorsal, posterior, ventral, left lateral views, X 4. Locality 5.
16, 20	Cranidium and incomplete right free cheek: anterior, right lateral views, X 3. Locality 6.
18, 19, 21, 22	Pygidium: dorsal, left lateral, interior, posterior views, X 4. Locality 5.
23	Cranidium, posterior portion of glabella and left fixed cheek, showing muscle areas and pitting in external surface, oblique exterior view, X 10. Original of Figure 4. Locality 5.

PLATE 33

Lonchodomas carinatus Cooper, 1953
Lower Edinburg formation

Figure	
1-3, 4, 7	Meraspid degree 1, lacking free cheeks: anterior, left lateral, posterior, dorsal, ventral views, X 15. Willow Grove, about 3 miles south of Woodstock, Shenandoah County, Virginia.
5, 6, 8	Small cranidium: anterior, right lateral, dorsal views, X 15. Locality 2.
9, 11, 12	Small cranidium and right free cheek, doublure broken at midline: right lateral, dorsal, anterior views, X 9. Locality 6.
10, 13, 15	Small pygidium: dorsal, ventral, posterior views, X 15. Locality 6.
14, 16, 17	Cranidium and incomplete right free cheek: right lateral, dorsal, anterior views, X 6. Locality 2.
18, 21	Pygidium: dorsal, posterior views, X 15. Locality 2.
19, 22, 23, 26, 29, 30	Meraspid degree 4, lacking free cheeks: right lateral, dorsal, anterior views, X 6; posteroventral, ventral, posterior views, X 9. Willow Grove, about 3 miles south of Woodstock, Shenandoah County, Virginia.
20, 25	Pygidium: dorsal, posterior views, X 6. Locality 2.
24, 27, 28	Cranidium and right free cheek, doublure broken near midline: anterior, dorsal, right lateral views, X 3. Locality 2.
31, 32	Cranidium, original of Plate 32, figure 4: ventral, oblique interior views, showing muscle areas of glabella and anterior boss, X 3. Locality 5.

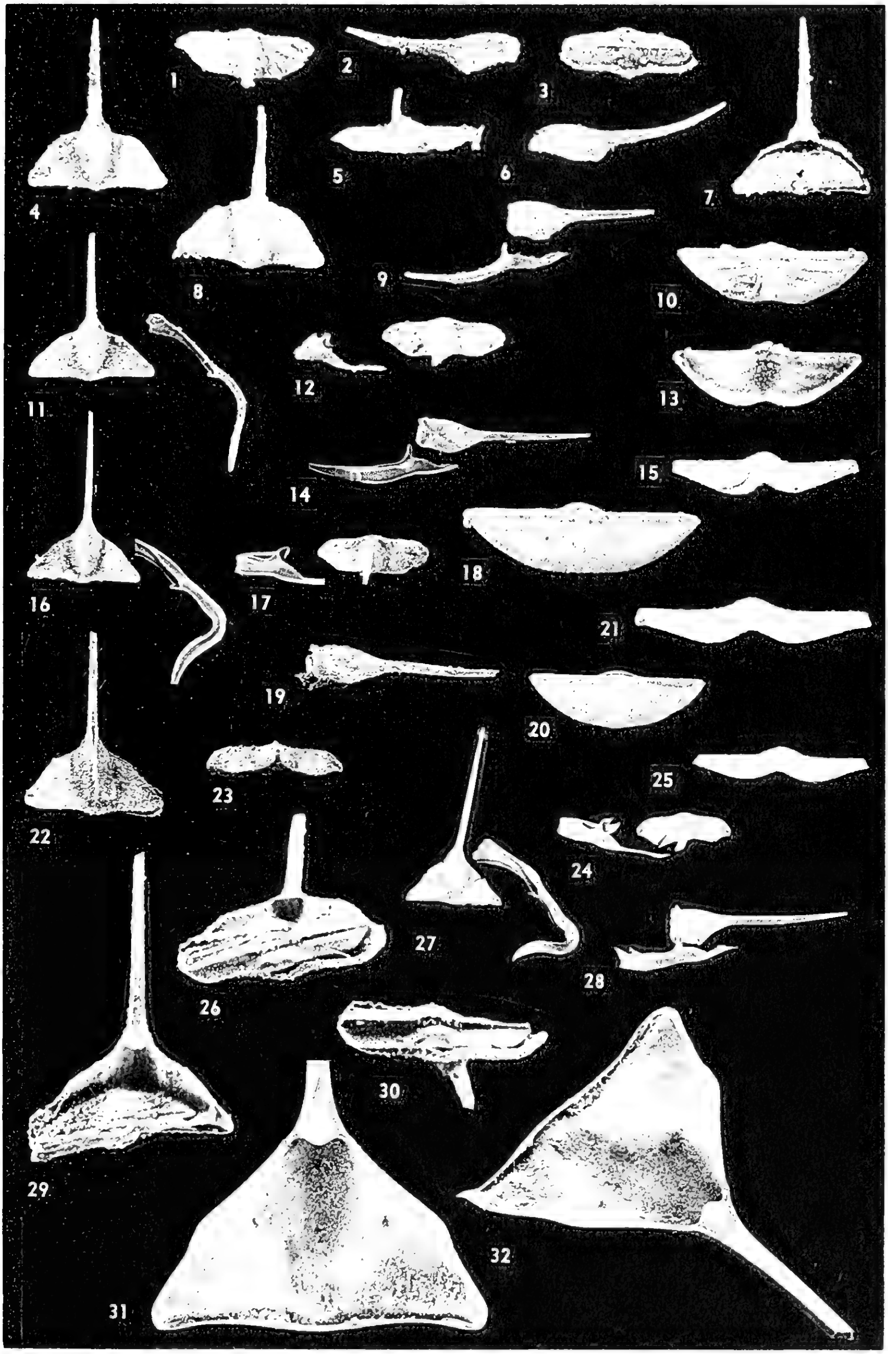
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PLATE 33

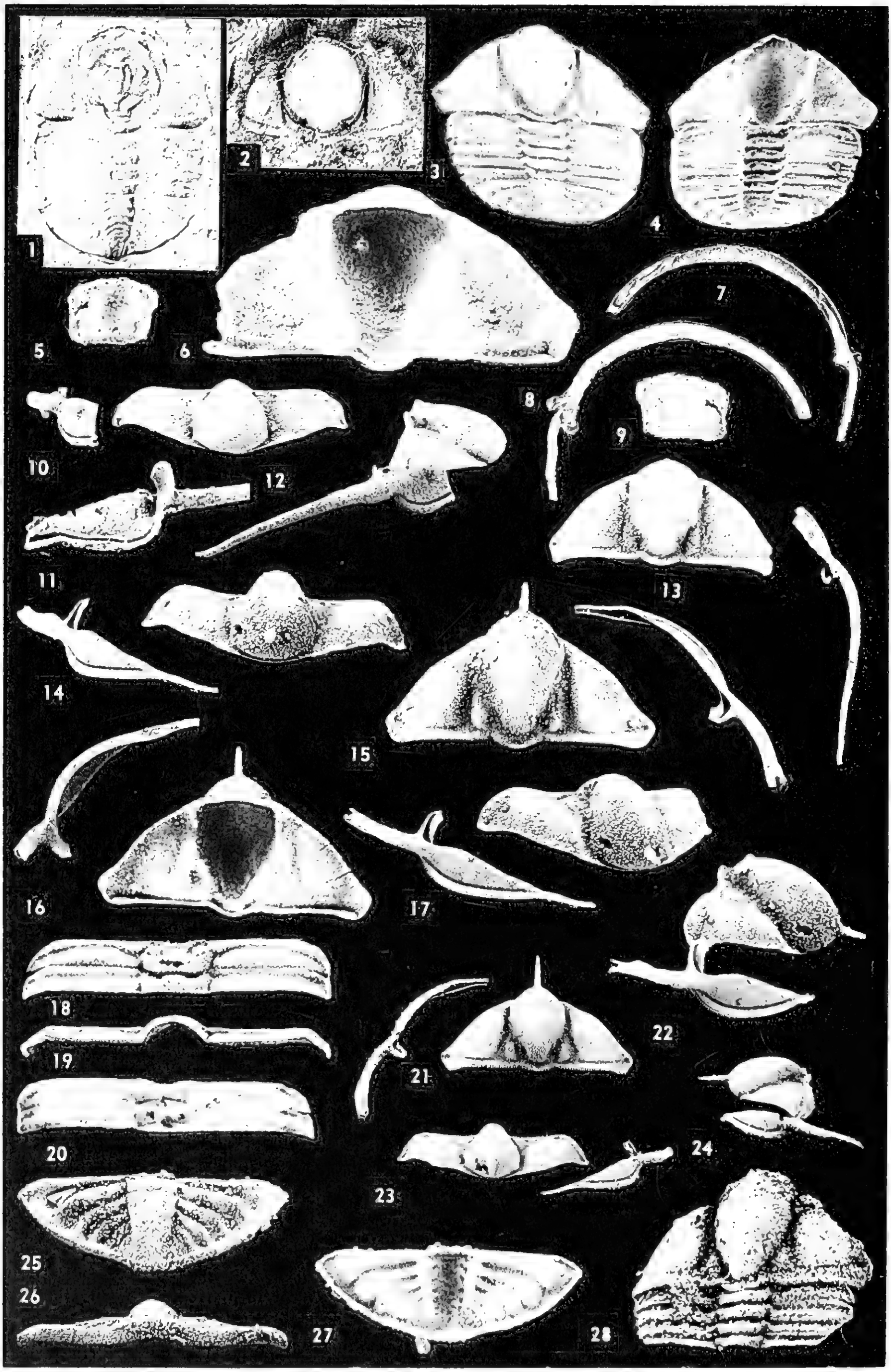

PLATE 34

PLATE 34

Ampyxina bellatula (Savage, 1917)
Thebes Sandstone, Thebes, Illinois

Figure	
1	Holotype, external mold lacking free cheeks, X 3. Original of Savage, 1917, plate 1, figure 3, USNM 72140.
2	Internal mold of cranidium, X 3. Original of Savage, USNM 72140.

Ampyxina powelli (Raymond, 1920)
Lower Edinburg formation

3, 4	Exoskeleton lacking free cheeks: dorsal, ventral views, X 6. Locality 14.
5, 9	Hypostome: interior, exterior views, X 15. Locality 14.
6	Incomplete cranidium: interior view, X 10. Locality 5.
7, 8	Right free cheek and anteromedian portion of doublure: dorsal, ventral views, X 4. Locality 14.
10, 12, 13	Cranidium and incomplete right free cheek: anterior, right lateral, dorsal views, X 6. Locality 5.
11	Incomplete free cheek: oblique interior view, X 10. Locality 14.

Ampyxina lanceola n.sp.
Lower Edinburg formation, locality 16

14-17, 22	Holotype cranidium, USNM 137692, and paratype right free cheek, USNM 137693a: anterior, dorsal, ventral, anterolateral, right lateral views, X 6.
18, 19, 20	Paratype thoracic segments, USNM 137693b: dorsal, posterior, ventral views, X 9.
21, 23, 24	Cranidium and left free cheek, doublure broken near midline: dorsal, anterior, left lateral views, X 6.
25, 26, 27	Paratype pygidium, USNM 137693c: dorsal, posterior, ventral views, X 6.
28	Cranidium and four thoracic segments: exterior view, X 9.

PLATE 35

Ampyxina powelli (Raymond, 1920)
Lower Edinburg formation

Figure	
1-3	Meraspid cranidium: dorsal, ventral, anterior views, X 30. Locality 5.
4, 8, 9	Meraspid degree 3, lacking free cheeks, transitory pygidium flexed down: left lateral, ventral, posterior views, X 15. Locality 14.
5, 6, 10, 11	Meraspid degree 2: dorsal, ventral, anterior, left lateral views, X 15. Locality 14.
7	Meraspid degree 3, lacking free cheeks: dorsal view, X 15. Locality 14.
12	Meraspid degree 4, lacking free cheeks: dorsal view, X 15. Locality 14.
13, 14	Meraspid degree 5, lacking free cheeks: dorsal, ventral views, X 15. Locality 14.
15	Right posterolateral portion of cephalon including part of glabella and right cheek: oblique exterior view, X 15. Locality 14.
16, 25	Meraspid degree 5, lacking free cheeks, larger than original of figures 13, 14: dorsal, ventral views, X 9. Locality 14.
17-20	Cranidium: dorsal, anterior, ventral, left lateral views, X 15. Locality 5.
21-24	Cranidium: anterior, right lateral, dorsal, ventral views, X 15. Locality 5.

Ampyxina lanceola n.sp.
Lower Edinburg formation, locality 16

26-28	Small cranidium: anterior, left lateral, dorsal views, X 15.
29, 32, 35	Cranidium and right free cheek: dorsal, right lateral, anterior views, X 15.
30, 31	Pygidium: posterior, dorsal views, X 15.
33, 34	Pygidium: posterior, dorsal views, X 9.

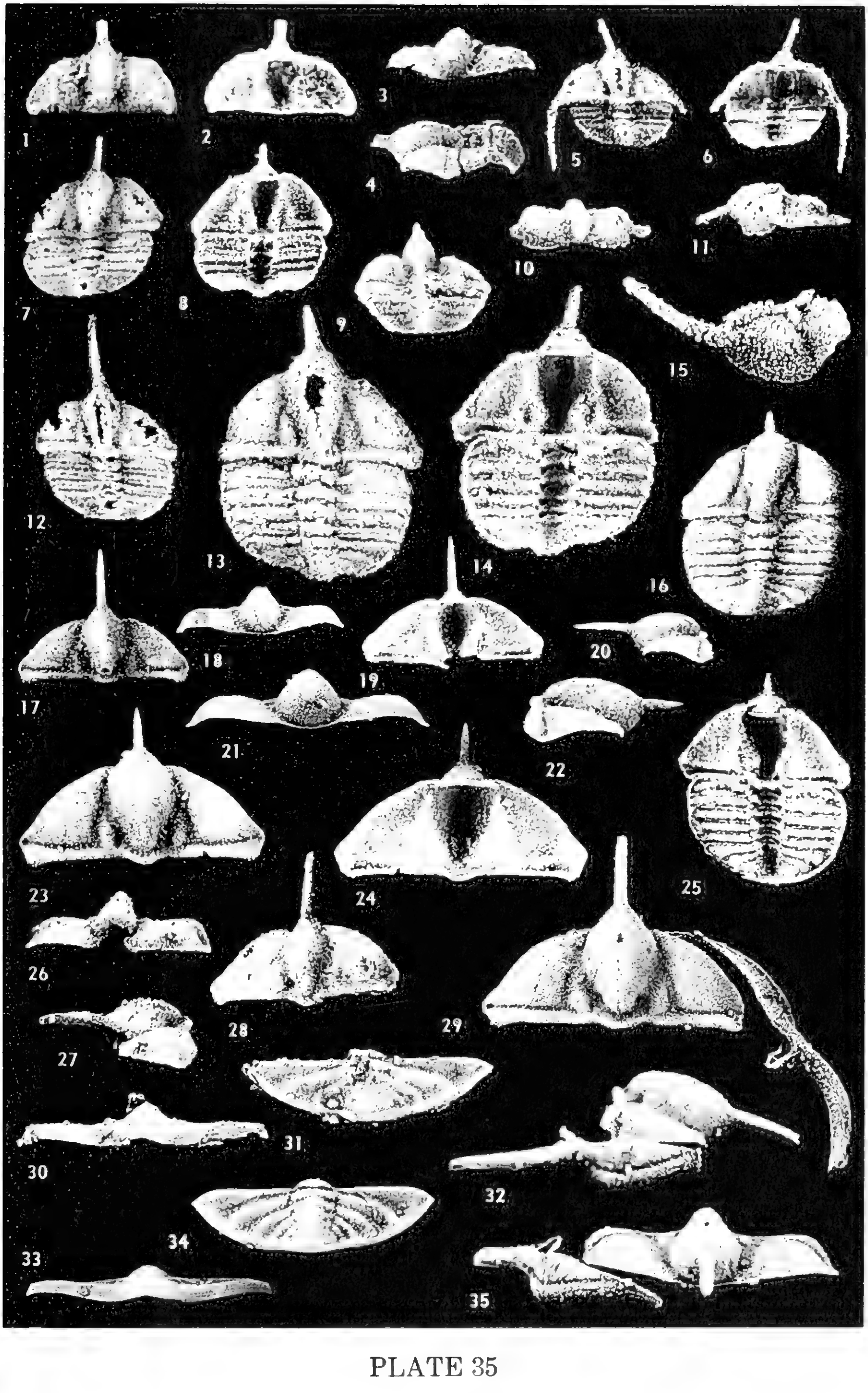
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PLATE 35

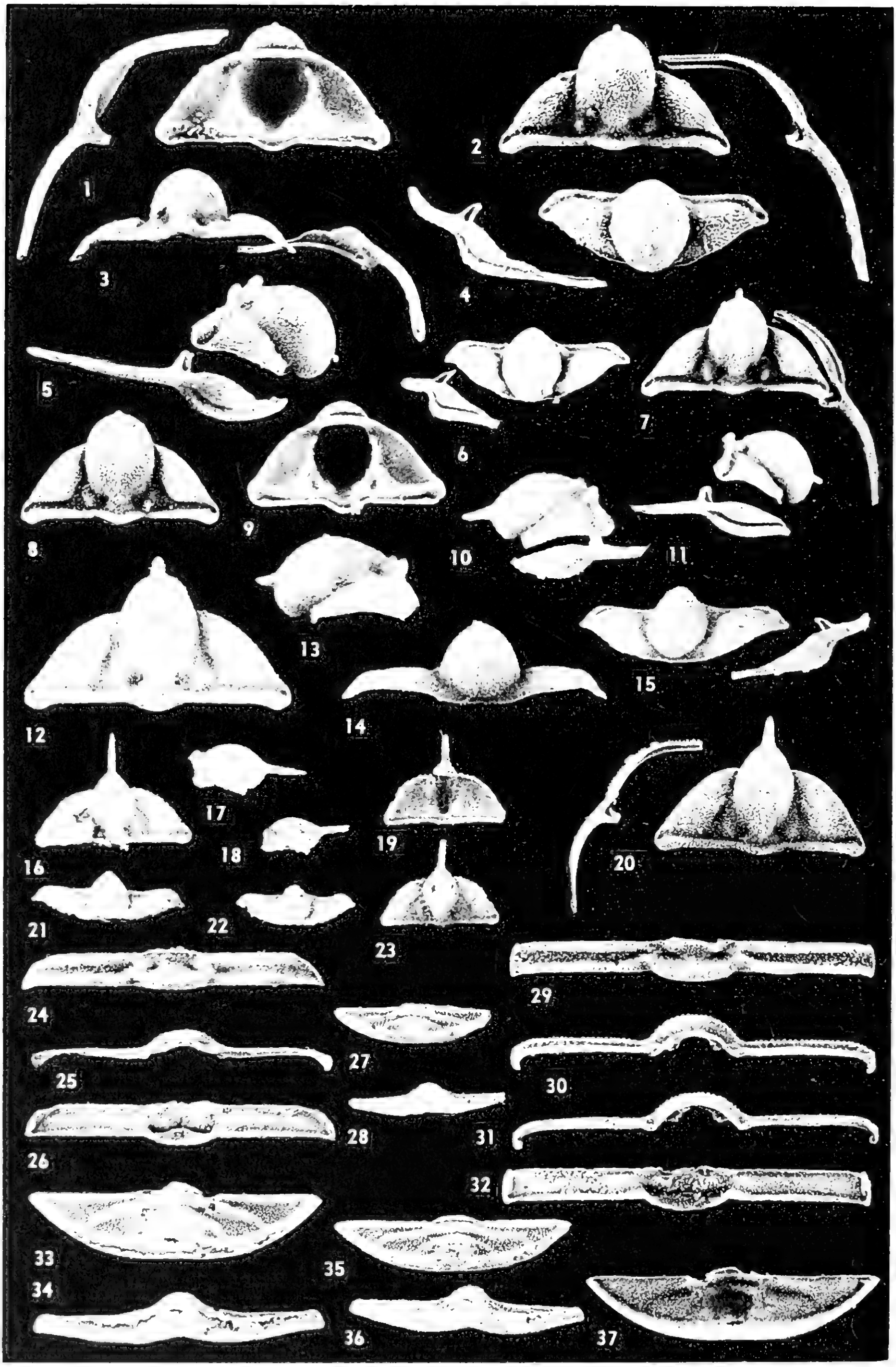
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PLATE 36

PLATE 36

Raymondella elegans (Cooper, 1953)
Lower Edinburg formation, locality 7

Figure	
1-5	Cranidium and right free cheek, doublure broken just beyond midline: ventral, dorsal, posterior, anterior, right lateral views, X 9.
6, 7, 11	Cranidium and right free cheek: anterior, dorsal, right lateral views, X 9.
8, 9	Cranidium: dorsal, ventral views, X 9.
10, 15, 20	Cranidium and left free cheek: left lateral, anterior, dorsal views, X 15.
12-14	Cranidium: dorsal, left lateral, anterior views, X 15.
16, 17, 21	Small cranidium: dorsal, right lateral, anterior views, X 15.
18, 19, 22, 23	Small cranidium: right lateral, ventral, anterior, dorsal views, X 15.
24-26	Anterior thoracic segment: dorsal, anterior, ventral views, X 15.
27, 28	Small pygidium: dorsal, posterior views, X 15.
29-32	Thoracic segment: dorsal, anterior, posterior, ventral views, X 15.
33, 34, 37	Pygidium: dorsal, posterior, ventral views, X 15.
35, 36	Pygidium: dorsal, posterior views, X 15.